A Longitudinal Examination of Bidirectional Associations between Subjective Sleep Characteristics and Psychosocial Functioning among University Students

by

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A thesis
submitted in partial fulfilment
of the requirements for the degree
of Doctor of Philosophy

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August 2014

To the memory of my mother, Joycelyn Jno Rose – who never prevented me from asking questions and always encouraged me to seek answers.

Abstract

A number of studies have found a significant link between sleep and psychosocial functioning among university students. A critical examination of this literature, however, indicates that one important gap within the literature is the need for longitudinal studies that specifically test for bidirectional associations between these two constructs. The main purpose of my dissertation was to address this gap by conducting three studies that examined bidirectional associations between sleep and psychosocial functioning among a sample of university students. Participants were 942 (71.5% female) undergraduate students enrolled at a Canadian university, who completed survey assessments annually for three consecutive years, beginning in their first year of university. In the first study, I assessed bidirectional associations between two sleep characteristics (sleep quality and sleep duration) and three psychosocial functioning variables (academics, friendship quality, and intrapersonal adjustment). Results based on cross-lagged models indicated a significant bidirectional association between sleep quality and intrapersonal adjustment, such that more sleep problems predicted more negative intrapersonal adjustment over time, and vice versa. Unidirectional associations indicated that both higher academic achievement and more positive friendship quality were significant predictors of less sleep problems over time. In the second study, in which I examined bidirectional associations between sleep and media use, results provided support only for unidirectional associations; such that more sleep problems predicted increases in both time spent watching television and time spent engaged in online social networking. In the third study of my dissertation, in which I examined social ties at university and sleep quality, results indicated a significant bidirectional association, such that more positive social ties

predicted less sleep problems over time, and vice versa. Importantly, emotion regulation was a significant mediator of this association. Findings across the three studies, highlight the importance of determining the direction of effects between different sleep characteristics and various aspects of university students' psychosocial functioning, as such findings have important implications for both methodology and practice. A better understanding of the nature of the associations between sleep and psychosocial functioning will equip students, parents and university administrators with the tools necessary to facilitate successful adjustment across the university years.

Keywords: bidirectional, longitudinal cross-lagged models, psychosocial adjustment, sleep, university students

Acknowledgements

I would like to extend my deepest gratitude to my supervisor, Dr. Teena Willoughby, for her endless edits, feedback, and insight on my dissertation. Her passion for research and scholarship, as well as her dedication to shape her students into well-grounded researchers is unsurpassed. I will remain forever grateful for all the support that Dr. Willoughby has provided me with over the past five years. I am also grateful for my two committee members, Dorothy Markiewicz and Linda Rose-Krasnor, for all of their feedback and insightful comments on my dissertation. It was also a real treat having them both as part of my Focal Area Research Seminars. I am grateful for the mentors that I directly encountered in the capacity of lecturer, research apprenticeship mentor, and/or advanced study supervisor: Dr. Michael Busseri, Dr. Cheryl McCormick, Dr. Teena Willoughby, and Dr. John McNamara. Moreover, I consider myself immensely blessed to have pursued my Ph.D within a very supportive lab. Thank you to all the members of the Adolescent Development lab – and in particular to Chloe Hamza, Paul Adachi, and Marie Bruton-Good, who saw me at the start of this journey. I am thankful for having had them as lab mates, but I am even more grateful for continuing to have them as true friends. I extend sincere appreciation to my adopted parents, Charles and Sue Armitage, for their unyielding love and support throughout this journey; I will never lose sight of the fact that some of the ideas that subsequently materialized into published manuscripts were born over late night chats on the sofa. I am immensely blessed to have the both of you in my life. I am thankful for my sister, Karllen Lawrence, for being a solid rock in my life; a constant source of support during the many high points, low points, and turning points of my graduate career. To my immediate family/siblings in Dominica: Kendra Roach, Alpha

Roach, and Royson Tavernier, as well as my niece, Kayla Alexander – thank you for believing in me and keeping me motivated. I also extend special thank you to my high school English teacher, Jo-Anne Xavier-Cuffy - who I am so honored to call friend, confidante, and cheerleader! Thank you to my roommates, Samantha Metler and Malisa Kurtz for being able to relate to and share in my graduate school experience; but more importantly, thank you for making our apartment a place that I was always happy to come home to, especially after long nights of data analysis. Thank you to all my close friends, both here and abroad, whose support and encouragement carried me through these past few years. Lastly, I am both humbled by and grateful for my faith in God – for the many opportunities that have been provided to me in facilitating the successful completion of this chapter in my life – thank you Lord!

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A Longitudinal Examination of Bidirectional Associations between Subjective Sleep Characteristics and Psychosocial Functioning among University Students

Chapter 1: Introduction

Both sleep and psychosocial functioning have received considerable attention within the developmental literature, particularly within the context of the emerging adulthood age period. Still, despite the rich body of literature examining the link between sleep and psychosocial functioning within this population, longitudinal research in this area is limited. The primary goal of my dissertation was to specifically address the lack of studies that assess bidirectional associations between sleep and psychosocial adjustment variables within a relatively long-term longitudinal context. My dissertation work, therefore, serves as an important extension to the sleep and psychosocial adjustment literature, which has generally relied on concurrent data.

Three longitudinal studies were conducted, based on a Canadian sample of emerging adults at university, who were assessed annually for three consecutive years beginning in their first year of university. All three studies assessed different sleep characteristics (e.g., sleep quality, sleep duration) and various indices of psychosocial functioning (e.g., academic achievement, friendship quality, media use) relevant to university students. An examination of the specific nature of the associations between sleep characteristics and psychosocial functioning provides important insight into the direction of effects between these two constructs and inform both theory and practice. For example, findings from my dissertation have important methodological implications for the ways in which researchers conceptualize sleep and psychosocial adjustment variables

(i.e., either as predictors or outcomes). Findings also have important practical implications for students, parents, as well as university administrators.

My role as first author on all three published studies reflects my initiative in the conceptualization of each study. As lead author, I was responsible for the writing of a full draft of each manuscript submitted for publication. Statistical analyses were done independently, as well as in collaboration with my supervisor, who is the second author on each of the three publications.

Sleep Characteristics

Across the fields of psychology, biology, and neuroscience, decades of research have provided important information regarding the correlates of an important human behavior – sleep (Espie, 2002; Jenkins & Dallenbach, 1924; Kahn-Greene, Lipizzi, Conrad, Kamimori, & Killgore. 2006; Vandekerckhove & Cluydts, 2010; Walker & van der Helm, 2009). For example, findings from experimental studies have provided empirical support for the role that sleep *duration* (i.e., the length of time spent asleep) plays for both memory consolidation (Smith, 2001; Stickgold, Hobson, Fosse, & Fosse, 2001) and effective processing of emotional stimuli (Cote, Mondloch, Sergeeva, Taylor, & Semplonius, 2013; Walker & van der Helm, 2009). Past research also supports the importance of sustained regularity in sleep-wake timing (i.e., maintenance of consistent bed times and wake times across week and weekend) for optimal psychosocial functioning. Specifically, more inconsistent sleep-wake patterns have been significantly linked to lower academic achievement (Gaultney, 2010; Wolfson & Carskadon), higher depressive mood among female high school students (Wolfson & Carskadon), and anxiety (Perfect, Levine-Donnerstein, Archbold, & Goodwin, 2014). Furthermore,

researchers have emphasized the important role of subjective sleep *quality* for overall health and psychosocial functioning (Mauss, Troy, LeBourgeois, 2013; Pilcher, Ginter, & Sadowsky, 1997). Thus, past research has provided a solid foundation for the investigation of sleep and psychosocial functioning by highlighting the importance of assessing multiple facets of sleep behavior. In line with past research, therefore, I have incorporated measures that assess different aspects of sleep (e.g., sleep duration, subjective sleep quality, and sleep-wake irregularity) across the three studies of my dissertation.

Developmental Context & Psychosocial Functioning

A key aspect of sleep research within developmental psychology has been the recognition that, across the lifespan, there are marked biological (e.g., puberty) and social/environmental (e.g., living with roommates, having a bed partner) changes that have important implications for sleep characteristics. Thus, developmental researchers - whose theoretical/research paradigms are premised on explicating human behaviour in the context of developmental changes across the lifespan (Baltes & Goulet, 1971) - play a particularly salient role in advancing sleep research. Within the literature, emerging adulthood has been noted as a potentially sensitive age period for the study of sleep characteristics and psychosocial functioning, specifically within the context of university students (Gilbert & Weaver, 2010; Shaikh & Deschamps, 2006). In Westernized cultures, emerging adulthood (18 – 25 years) – particularly for university students - is conceptualized as an age period during which individuals are typically faced with unstable living conditions, such as moving away from home to attend university, then moving again from university residence to off-campus housing; and moving yet again

back home between university completion and obtaining a stable career/job (Arnett, 2000). For some university students, instability regarding career choices also may ensue, as university students may change academic majors across university (Elias & Loomis, 2000). Additionally, university students have increased autonomy relative to adolescents (e.g., become of legal drinking age) and also generally experience less direct supervision from parents (Ainsworth, 1989). Of note, university students have been characterized as having fewer responsibilities than adults, given that decisions about marriage and children often now are delayed until the late 20's (Arnett, 2000, 2007). These characteristics, typical of university students, provide an intriguing context for the study of sleep characteristics and psychosocial functioning.

Throughout the three studies of my dissertation, my focus on examining various indices of psychosocial functioning (e.g., academics, interpersonal relationship quality) was premised on key developmental theories that emphasize the importance of examining adjustment across various domains of life, including work/career, interpersonal relationships, and intrapersonal/emotional well-being (Havighurst, 1972, Erikson, 1968). According to the theory of *developmental tasks*, for example, the 18 – 30 year age period is characterized by efforts to accomplish the developmental tasks of starting a career and establishing close social ties with others, among other tasks such as civic responsibility (Havighurst, 1972). Importantly, accomplishing developmental tasks – which often are specific to each age period – sets the foundation for mastering other developmental tasks in subsequent age periods and also promotes optimal well-being and adjustment as the individual transitions across the lifespan (e.g., Havighurst, 1972; Masten et al., 2004). For example, Roisman, Masten, Coatsworth and Tellegen (2004) found that higher academic

achievement assessed at age 20 significantly predicted both work competence and quality of romantic relationships assessed approximately 10 years later. Thus, among university students, academic achievement may provide a valid indicator of individuals' efforts towards the establishment of a career and, additionally, may provide some insight into an individual's adjustment in other domains of life, such as interpersonal relationships (Roisman et al., 2004).

Moreover, according to Erikson's (1978) *Theory of Psychosocial Development*, during the emerging adulthood age period, individuals typically grapple with issues relating to intimacy. According to Erikson (1978), the unsuccessful establishment of a long-term, committed relationship with a significant other results in the experience of profound feelings of isolation. Importantly, close friendships among university students have been noted as an important context for the development of intimacy with others and thus assessments of interpersonal relationship functioning beyond romantic partners may be a valid indicator of adjustment among university students (Buote et al., 2007).

Furthermore, *Attachment Theory* (Bowlby, 1988) posits that the formation of a secure bond with a caregiver early in life facilitates successful adaptation in subsequent relationships in later age periods (Ainsworth, 1989). Over time, individuals' past experiences inform their "internal working models" of the self and others (Griffin & Bartholomew, 1994a). More specifically, a positive "self" model refers to an individual's sense of self-worth, such that greater self-worth leads to greater expectation that the individual will be treated favorably by others. On the other hand, a positive "other" model, captures the extent to which an individual perceives others as supportive and generally available (Griffin & Bartholomew, 1994b). These internal working models are

believed to be important aspects underlying individuals' quality of their interpersonal relationships (Griffin & Bartholomew, 1994b). Taken together, these developmental theories provide a convincing rationale for the study of psychosocial functioning among emerging adults.

Another critical aspect of psychosocial adjustment among university students is emotional/intrapersonal functioning (Fredrickson & Joiner, 2002). University students, who are typically faced with both challenges and opportunities for emotional experiences (Eisenberg, Gollust, Golberstein, Hefner, 2007), may draw on personal (e.g., self-esteem) and social (e.g., friendships) resources to develop effective emotion regulation strategies (e.g., Friedlander, Reid, Shupak, & Cribbie, 2007). Within the literature, researchers have expressed interest in examining correlates of depression and anxiety (among other emotional well-being indices) among university students (Chasin, Pitts, & Prost, 2002; Galambos, Barker, & Krahn, 2006; Orth, Robins, & Roberts, 2008; Reinherz, Paradis, Giaconia, Stashwick, & Fitzmaurice, 2003). Importantly, concerns about emotional well-being have been explored within the context of sleep characteristics across the lifespan and findings suggest that poor sleep quality is associated with more negative emotional well-being (Jackowska, Dockray, Hendrickx, Steptoe, 2011; Lund et al., 2010; Mauss, Troy, Bourgeois, 2013; Riemann et al., 2010; Walker, & vander Helm, 2009).

The Case for Examining Bidirectional Associations

Although there is a rich body of literature exploring the link between sleep characteristics and various indices of psychosocial functioning (e.g., depressive symptoms, anxiety, affect, stress, academic achievement, alcohol consumption, and interpersonal relationship quality) among university students (Ari & Shulman, 2012;

Cheng et al., 2012; Gilbert & Weaver, 2010; Orzech, Salafsky, & Hamilton, 2011; Singleton & Wolfson, 2009), important gaps within the literature remain. One of these gaps is a lack of studies assessing the direction of effects between sleep characteristics and psychosocial functioning within a relatively long-term longitudinal context, as the majority of studies have been based on concurrent data (e.g., Becker et al., 2008; Gaultney, 2010; Lund et al., 2010). This is a key limitation of past work because, although findings from concurrent data provide valuable information regarding the associations between variables at one point in time, analyses based on concurrent data preclude any valid assessment of the temporal ordering of effects between variables (Taris, 2000). Among studies that have been based on longitudinal data, the majority either have been with children and adolescent (Adam et al., 2010; Gregory et al., 2009) or older adult samples (e.g., Haario, Rahkonen, Laaksonen, Lahelma, & Lallukka, 2013; Jansson-Fröjmark & Lindblom, 2008), and/or have tested unidirectional models of sleep and psychosocial functioning (e.g., predictive effect of insomnia on depression onset – see Riemann & Voderholzer, 2003 for a review).

Summary of the Three Published Studies

In the **first study** of my doctoral dissertation, I examined the direction of effects between two important sleep characteristics (i.e., sleep duration and subjective sleep quality) and three indices of psychosocial functioning (i.e., academic achievement, friendship quality, and intrapersonal adjustment). Both subjective sleep quality and sleep duration have been significantly linked to academics in past research (e.g., Gaultney, 2010; Orzech et al., 2011), but past studies have generally been limited by concurrent designs. Furthermore, past research has yielded mixed findings regarding the importance

of sleep quality and sleep duration for academic achievement (Gray & Watson, 2002; Singleton & Wolfson, 2009). As I already mentioned, findings from sleep deprivation studies have highlighted the importance of sleep for memory consolidation (Stickgold et al., 2001; Walker & van der Helm, 2009). Thus one would expect that shorter sleep duration would potentially have negative implications for students' academic performance, given the large amount of learning required for success in most university courses. Nevertheless, students may need to compromise on the amount of sleep they get each night in order to invest more time studying or completing assignments – activities that also are important for academic success at university.

Moreover, although academic success is a prime indicator of psychosocial functioning within this population (Roisman et al., 2004), the quality of interpersonal relationships also plays a significant role in university students' overall adjustment (Cacioppo et al., 2002). For this reason, I felt it necessary also to assess friendship quality. Positive interpersonal relationships have been significantly linked with subjective sleep quality in past research but conclusions regarding the direction of effects between the two constructs have generally been inferred from concurrent data (Cacioppo et al., 2002; Smith et al., 2010; Chandola, Marmot, Siegrist, 2007). It was necessary, therefore, to determine whether the findings from my dissertation would provide support for this hypothesized direction of effects (i.e., that interpersonal relationship quality precedes better sleep quality) or whether better sleep would precede more positive interpersonal relationship quality. Another possibility that remains to be tested is whether the association between interpersonal relationship quality and sleep quality is bidirectional.

Furthermore, the rationale for including a measure of *intra*personal adjustment was premised on the rich body of past literature that has demonstrated, quite consistently, a significant association between negative intrapersonal adjustment and poor sleep quality (Fortunato & Harsh, 2006; Galambos et al., 2009; Lund et al., 2010; Pilcher, Ginter, & Sadowsky, 1997). For the purposes of our study, the construct of intrapersonal adjustment was operationalized as a composite of depressive symptoms, self-esteem, and daily hassles/stress.

Research evidence based on both concurrent and longitudinal studies has supported the link between poor intrapersonal functioning and more negative sleep characteristics (Baglioni, Spiegelhalder, Lombardo, & Riemann, 2010; Riemann & Voderholzer, 2003). Still, one limitation of this research is that longitudinal studies of sleep and intrapersonal adjustment generally draw conclusions regarding the temporal ordering of effects based on unidirectional models (but see Galambos et al. 2009; Garde et al., 2012; Gregory, Rijsdijk, Lau, Dahl, & Eley, 2009; Jansson-Fröjmark & Lindblom, 2008; for exceptions). For example, evidence from a review article on insomnia (i.e., poor sleep quality) and depression indicated that across studies, reports of insomnia at baseline were significantly associated with higher odds of developing depression at follow-up, thus supporting the finding that poor sleep quality precedes negative intrapersonal adjustment (Riemann & Voderholzer, 2003). Based on this unidirectional model, however, the study's methodological design does not provide a test of the alternative direction of effects from poor intrapersonal adjustment to poor sleep problems (Baglioni et al., 2009). Importantly, Study 1 of my dissertation was the first study specifically to test the temporal ordering of effects between sleep quality (and duration)

and intrapersonal adjustment with a sample of university students within a relatively long-term longitudinal context (i.e., across three years).

The purpose of the **second study** of my dissertation was to determine the direction of effects between two sleep characteristics (i.e., sleep quality and sleep duration) in relation to two indices of media use (i.e., time spent watching television and time spent engaged in online social networking). Advances in technology, coupled with increased ease of accessibility of these technologies, have led to increased concern among the general public as well as researchers (Brown, 2006) regarding the possible implications that media use may have for overall adjustment and well-being. A critical examination of this literature, however, yields two important gaps: 1) the majority of studies have assumed directionality from media use to sleep problems based on concurrent data and 2) studies have generally been based on children and adolescent samples, with very little research on university students.

Although there are compelling theorized mechanisms regarding the predictive effect of media use on poor sleep (Zimmerman, 2008), an empirical test of these proposed hypotheses of a unidirectional association is warranted. Determining the temporal ordering of effects between sleep characteristics and media use will further provide an empirical basis for exploring possible mediating factors that could potentially explain the association (be it unidirectional from media use to sleep; or from sleep to media use; or bidirectional, such that sleep and media use share reciprocal effects). Furthermore, determining the direction of effects between sleep and media use was an important research question given both the pervasiveness of media use in our society

(Brown, 2006), as well as concerns regarding the potential negative implications of media use on sleep characteristics (Zimmerman, 2008).

In particular, although children and adolescents have been found to spend a significant amount of time engaged in some form of media use, data based on representative samples from Canada (Statistics Canada, 2010) and the United States (U.S Census Bureau, 2010) have indicated that media use is more prevalent among emerging adults relative to children and adolescents. As I previously mentioned, university students (relative to children and adolescents) have increased autonomy, which may have important implications for how they spend their time – including their use of media. Given that university students already are faced with the challenge of balancing academic and social demands – factors that have been shown to be associated with sleep characteristics within this population (Galambos et al., 2009, 2013) - it is of critical importance that developmental researchers further investigate the role of media in relation to sleep characteristics among university students.

In the **third study** of my dissertation, I addressed two main objectives: 1) To determine the temporal ordering of effects between sleep *quality* and social ties at university (controlling for sleep duration, weekend delay, weekend oversleep, and alcohol use) and 2) To assess the possible mediating role of emotion regulation in the link between sleep quality and social ties at university. There is a rich body of literature examining the association between positive interpersonal relationships and various aspects of psychosocial functioning (e.g., Berkman & Syme, 1979; Chandola et al., 2007; Cohen et al., 1997; House et al., 1988; Puyat et al., 2013). These studies have generally concluded that healthy social relationships with others precede positive psychosocial

functioning (e.g., Cacioppo et al., 2002). Still a gap within the literature was to determine the extent to which social ties *specific to the university* setting would be associated with university students' sleep quality.

Although I assessed the association between friendship quality and sleep quality in Study 1, the measure of friendship quality did not specifically differentiate between friends at university and friends outside of university. Importantly, given the marked changes in friendships that occur following individuals' transition from high school to university (Oswald & Clark, 2003), I thought it necessary to tease apart the specific role that university students' social ties *at university* would play in relation to their perceived quality of sleep. Also noteworthy is the fact that social ties at university may include roommates/housemates who may share living space with students and thus would be expected to be associated with their sleep quality (e.g., noisy roommates may interfere with initiating sleep). Moreover, given that the hypothesized direction of effects has been from social relationships to sleep quality, I specifically tested a bidirectional model to assess the specific direction of effects between social ties at university and sleep quality.

Additionally, in anticipation of a significant link between social ties at university and sleep quality, I proposed a test of the mediating role of emotion regulation. Within the literature, more negative emotional well-being consistently has been linked to poorer social relationships (e.g., Brummett et al., 2006; Heinrich & Gullone, 2006; Zawadzki et al., 2013). More negative emotional well-being also has been linked to poorer sleep quality (Cheng et al., 2012; Ohayon, 2002; Soehner et al., 2007). In fact, past research has provided empirical evidence supporting a significant bidirectional association between sleep quality and emotional well-being/ maladjustment (e.g., Baglioni et al.,

2009; Kelly & El-Sheikh, 2013). Thus, the hypothesized mediating role of emotional regulation in the association between social ties at university and sleep quality was premised on past research supporting a link between sleep and emotional well-being, as well as between social ties and emotional well-being. Importantly, moving beyond predictive effects of social ties on sleep quality (and vice versa) to an examination of a potential mediator of this association, extends the current literature by providing a possible explanatory mechanism that will yield a deeper understanding of *how* these two constructs are related.

Taken together, the three published studies of my dissertation are situated within a strong developmental framework, which emphasizes the need to examine multiple aspects of individuals' sleep and psychosocial functioning. The 3-year longitudinal design examining bidirectional associations between different sleep characteristics and various indices of psychosocial functioning provide an important extension to the literature. Finally, the assessment of these associations with a sample of university students is in keeping with the view that the university experience represents a time of increased challenges and opportunities and thus provides an opportune context for the study of such behaviors.

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Chapter 2 (Study 1): Bidirectional Associations between Sleep (Quality and Duration) and Psychosocial Functioning across the University Years[1]

Emerging adulthood is conceptualized as a sensitive period, with unique opportunities and challenges for psychosocial functioning (Arnett, 2000). Emerging adults, for example, have increased autonomy (e.g., become of legal drinking age) and often experience changes in living situation away from direct parental supervision (Arnett, 2007). As attending university becomes more commonplace within modern societies such as North America, researchers have increasingly focused on examining factors that relate to how individuals navigate the university years (Pratt, 2000). Moreover, lifespan theories such as developmental tasks (Havinghurst, 1972) and Erikson's theory of psychosocial development (Erikson, 1968) posit that the accomplishment of socio-cultural tasks at each developmental life stage is associated with positive psychosocial functioning within that period, and also lays the foundation for successful adjustment during subsequent life stages. Understanding the factors that relate to emerging adults' psychosocial functioning, therefore, is an important task for developmental researchers (Pratt, 2000).

One important factor that has been associated with psychosocial functioning among emerging adults at university is sleep (Becker, Adams, Orr, & Quilter, 2008;

[1] A version of this chapter has been published. Tavernier, R., & Willoughby, T. (2014). Bidirectional Associations between Sleep (Quality and Duration) and Psychosocial Functioning Across the University Years. *Developmental Psychology*, *50*, 674-682. DOI: 10.1037/a0034258.

Buboltz, Brown, & Soper, 2001). Prevalence rates of sleep problems (i.e., poor sleep quality) among students vary across studies, ranging from 9.7% to 54.7% (Cheng et al., 2012; Fernández-Mendoza et al., 2009). Researchers generally have found that poor sleep quality is associated with negative psychosocial functioning, such as higher alcohol use, negative affect, perceived stress (e.g., Galambos et al., 2009) and higher depressive symptoms (e.g., Moo-Estrella, Pérez-Benítez, Solís-Rodríguez, & Arankowsky-Sandoval, 2005). Shorter sleep duration (i.e., number of hours spent asleep) also has been associated with poorer psychosocial functioning, such as higher negative affect and perceived stress (e.g., Galambos et al., 2010).

Despite the extensive research on sleep and psychosocial functioning, one important gap in the literature remains the lack of longitudinal studies that examine the direction effects between these two constructs. The purpose of the present three-year longitudinal study, therefore, was to assess bidirectional associations between sleep (quality and duration) and three important indices of psychosocial functioning (i.e., intrapersonal adjustment, friendship quality, and academic achievement) among a sample of emerging adults at university. These three indices of psychosocial functioning were chosen because they correspond to three important developmental tasks of emerging adulthood (Havighurst, 1972; Roisman, Masten, Coatsworth, Tellegen, 2004) and have been included in studies of psychosocial functioning among emerging adults at university (Galambos, Howard, & Maggs, 2010; Gray & Watson, 2002; Pittman & Richmond, 2008).

Sleep and Intrapersonal Adjustment

A significant concurrent link between intrapersonal adjustment and sleep *quality* has been well-established within the literature. Individuals who report poorer sleep quality, for example, consistently report higher scores on negative affect (Fortunato & Harsh, 2006), depressive symptoms (Pilcher et al., 1997), and perceived stress (Galambos, Dalton, & Maggs, 2009; Lund et al., 2010). While some researchers propose that sleep quality may be an outcome of intrapersonal adjustment (Becker et al., 2008; Nakata et al., 2004), others have suggested that sleep quality may be a predictor of intrapersonal adjustment (Gray & Watson, 2002; Howell, Digdon, Buro, & Sheptycki, 2008). Studies based on a single assessment, however, do not account for the direction of effects (Becker et al., 2008; Lund et al., 2010) between these two constructs. Yet among studies that have employed multiple assessments of sleep and intrapersonal adjustment, authors have either collapsed scores across assessments and therefore failed to account for time precedence (Galambos et al., 2010; Orzech et al., 2011; Pilcher & Ott, 1998), or have a priori modeled a unidirectional effect (see Baglioni, Spiegelhalder, Lombardo, & Riemann, 2010; Riemann & Voderholzer, 2003 for reviews).

To the best of our knowledge, only four studies have specifically examined bidirectional associations between sleep quality and intrapersonal adjustment. First, Garde and colleagues (2012) found a significant bidirectional association between poor sleep quality and perceived stress over three days with their sample of Danish adults. Second, Galambos and colleagues (2009), in a fourteen-day study, only found support for a significant unidirectional association, such that better sleep quality predicted lower negative affect and less perceived stress but in turn negative affect and stress did not predict sleep quality. Third, among a sample of 8-year old twins, Gregory, Rijsdijk, Lau,

Dahl, and Eley (2009) only found support for a unidirectional association, such that parents' reports of their child's sleep problems at age eight significantly predicted children's reports of their depressive symptoms at age ten, controlling for previous scores on the outcome variable. The final bidirectional study, based on a sample of working adults, found a significant bidirectional association between insomnia and depression, as well as between insomnia and anxiety over the span of one year (Jansson-Fröjmark & Lindblom, 2008). No studies, however, have examined bidirectional associations between sleep quality and intrapersonal adjustment among a sample of emerging adults at university across a three-year time frame.

In terms of the association between sleep *duration* and intrapersonal adjustment, findings have been inconsistent. Some authors have found that shorter sleep duration is significantly associated with higher levels of stress, negative affect (Galambos et al., 2013; Galambos et al., 2010), and depression (Hamilton, Nelson, Stevens, & Kitzman, 2007). Other studies, however, have found no association between sleep duration and intrapersonal adjustment (Galambos et al., 2009; Pilcher et al., 1997). Additionally, these studies have generally been based on concurrent measurements (e.g., Hamilton et al., 2007). One reason for these inconsistencies may be because of significant individual differences in sleep need (Ferrara & De Gennaro, 2001) – such that individuals differ in the amount of sleep that they perceive to be ideal for their optimal psychosocial functioning (Taillard, Philip, & Bioulac, 1999).

Sleep and Interpersonal Relationships

In addition to intrapersonal adjustment, the maintenance of healthy interpersonal relationships is also an important developmental task of emerging adulthood (Havighurst,

1972). Some evidence suggests a significant link between sleep *quality* and interpersonal relationships (Cacioppo et al., 2002). Higher levels of interpersonal conflict (Fortunato, & Harsh 2006), as well as higher loneliness (Cacioppo et al., 2002; Smith, Kozak, & Sullivan, 2010), for example, have been significantly associated with poorer sleep quality. Based on concurrent findings, researchers generally have inferred that more positive interpersonal relationships may facilitate better sleep quality (Cacioppo et al., 2002; Smith et al., 2010) but few studies have actually tested the direction of effects. In one study, Garde and colleagues (2012) found a significant bidirectional association between interpersonal problems and sleep quality (as assessed by nocturnal awakenings) but only assessed these associations over a 3-day period. An important gap within the literature, therefore, is the need for long-term longitudinal studies that assess bidirectional associations between sleep quality and interpersonal relationships. A second gap is that assessments of interpersonal relationships are often aggregated across various sources, including friends and family (Orzech et al., 2011). Given the important role that friendships play among emerging adults at university (Pittman & Richmond, 2008), it is imperative that researchers examine the specific role of friendships in relation to sleep quality among this population.

Moreover, very few studies have examined the association between interpersonal relationships and sleep *duration*. The studies that have examined this association indicate that more positive interpersonal relationships are associated with longer sleep duration (Galambos et al., 2013; Hamilton et al., 2007). Galambos and colleagues (2009) also reported that more frequent socializing with friends during the day was associated with

longer sleep duration that night – but this finding was not replicated in a subsequent study (Galambos et al., 2010).

One reason for examining the association between interpersonal relationships and sleep is based on past findings that have indicated that positive interpersonal relationships are significantly linked to both physical health and emotional adjustment (Cohen, 2004; Cohen, Doyle, Skoner, & Gwaltney, 1997; Franks, Campbell, & Shields, 1992; Presman et al., 2005). Specifically, some authors have suggested that positive interpersonal relationship functioning may bolster emotional well-being through the provision of social support (e.g., Thoits, 1986). It follows, therefore, that interpersonal relationship functioning may be linked to sleep characteristics through emotional adjustment.

Sleep and Academic Achievement

Academic achievement has been used as a key index of psychosocial functioning among emerging adults at university (Roisman et al., 2004). Findings are mixed regarding the association between sleep *quality* and academic achievement: while some studies have found that poorer sleep quality is associated with lower academic achievement (Gaultney, 2010; Gomes, Tavares, & de Azevedo, 2011; Orzech et al., 2011), other researchers have found no association (Galambos et al., 2013; Gray & Watson, 2002). In terms of sleep *duration*, some authors have found shorter sleep duration to be a significant concurrent predictor of lower academic achievement (Gilbert & Weaver, 2010; Orzech et al., 2011). In contrast, others have found shorter sleep duration to be associated with higher academic achievement (Singleton & Wolfson, 2008; Trockel et al., 2000). Still others have found no significant association between sleep duration and academic achievement (Galambos et al., 2013; Gray & Watson, 2002).

Gender as a moderator

Significant gender effects (Buboltz et al., 2001; Orzech et al., 2011) have been found on sleep *quality* (with females reporting more sleep problems than males), although others have found no significant gender effects (Ban & Lee, 2001; Carney et al., 2006). Findings also are inconsistent with respect to gender differences and sleep *duration* (Ban & Lee, 2001; Orzech et al., 2011). Although there is some suggestion that males' and females' objective (Bixler et al., 2009) and subjective (Becker et al., 2008) sleep may be differentially affected by external stressors, no study has specifically examined the moderating role of gender in the context of bidirectional associations between sleep and psychosocial functioning.

The Present Study

Despite the high level of inquiry into the association between sleep (both quality and duration) and various indices of psychosocial functioning, an important empirical question regarding the direction of effects between these two constructs remains largely ignored within the literature. It is necessary to determine whether sleep quality and duration precede or result from psychosocial functioning, or whether the nature of these variables is mutual. Such knowledge will have far-reaching implications for addressing both sleep needs and psychosocial functioning among emerging adults at university. Thus, the purpose of the present 3-year longitudinal study was to examine bidirectional associations between sleep (quality and duration) and three indices of psychosocial functioning (intrapersonal adjustment, friendship quality, and academic achievement) among a sample of emerging adults at university.

We predicted that there would be a significant bidirectional association between sleep quality and intrapersonal adjustment but did not propose any directional hypotheses for the association between sleep duration and intrapersonal adjustment due to limited empirical evidence. Based on past research, we predicted that better friendship quality would significantly predict better sleep quality – but better sleep quality was not expected to predict friendship quality. Furthermore, based on the limited research on sleep *duration* and frequency of socializing with friends, we expected that sleep duration and friendship quality would be associated but we made no predictions regarding the direction of effects. In terms of sleep and academic achievement, we did not project any directional hypotheses for this research question because findings regarding both sleep quality and sleep duration in relation to academic achievement are quite mixed. We also assessed the role of gender as a possible moderator of the pattern of results.

Method

Participants

Participants were 1057 students enrolled at a mid-sized university in southern Ontario, Canada, who were assessed for three consecutive years. As academic grades were an important component of the present study, however, we excluded from our analyses students who dropped out or transferred out of the university (N = 115) as grades were not applicable or available. Our analyses, therefore, were based on 942 (71.5% female) students who remained registered at the university during the three years of the study (note, however, that we reran the analyses with the full sample and the pattern of findings did not differ).

At the first assessment, all participants were in their first year of university (M = 19.01 years, SD = 0.90, range of 17 to 25 years). Data on socioeconomic status indicated that mean levels of education for mothers and fathers fell between “some college, university, or apprenticeship program” and “completed a college/apprenticeship and/or technical diploma.” Our sample was comprised predominantly of domestic-Canadian students (88%), and common ethnic backgrounds of these students other than Canadian were British (19%), Italian (16.8%), French (9.5%), and German (9%), consistent with the broader demographics for the region (Statistics Canada, 2006). Of the international students, the majority were from Asia (36.1%), European Union (15.7%), the Caribbean (10.2%) and Africa (10.2%).

Procedure

First-year university students from various academic disciplines were invited to complete a survey examining factors related to stress, coping, and adjustment to university by way of posters, classroom announcements, website posting, and visits to on-campus student residences. Participants were given course credit or monetary compensation ($10) for their participation at Time 1, and monetary compensation for their participation at Time 2 ($20) and Time 3 ($30). At Time 2 and 3, all students who participated in the first assessment were invited to participate again, by way of emails, posters, and classroom announcements. At all three assessments, surveys were completed during the winter term. The study received ethics clearance by the University Research Ethics Board prior to survey administration at all three assessments (see Appendix L), and all participants provided informed active consent prior to participation. The survey was administered by trained research assistants.

Missing Data Analysis

Missing data occurred within each assessment time point because some students did not finish the entire questionnaire (average missing data = 1.5%) and because some students did not complete all three waves of the survey. Missing data analysis revealed that these missing data were missing at random (Schafer & Graham, 2002). Thus, missing data were estimated using the full information maximum likelihood (FIML) estimation method. FIML retains cases that are missing survey waves, thus avoiding the biased parameter estimates that can occur with pair-wise or list-wise deletion (Schafer & Graham 2002).

Measures

Demographics: Age, gender, and parental education (one item per parent, averaged for participants reporting on both parents, with a scale of *1 = did not finish high school* to *6 = professional degree*, $r = .40$) were assessed at Time 1, and were used as covariates in all analyses.

Sleep quality: Sleep quality was assessed using an adapted version of the Insomnia Severity Index (ISI; Morin, 1993). Specifically, one item was added: "Problems staying awake" and two items were deleted: i) "How noticeable to others do you think your sleep problem is in terms of impairing the quality of your life?" and ii) "How worried/distressed are you about your current sleep problem?" Thus, for the present study, four items assessed the severity of insomnia symptoms: difficulty falling asleep, staying asleep, problems waking up too early and problems staying awake, with responses ranging from *1 = no problem* to *5 = very severe problems*. Additionally, one item assessed the degree to which participants were satisfied with their sleep patterns on a

5-point Likert scale, ranging from *1 = very satisfied* to *5 = very dissatisfied*. The extent of participants' perceived daytime impairment as a result of their sleep patterns was also assessed, based on a 4-point Likert scale, ranging from *1 = rarely interferes* to *4 = very often interferes*. Cronbach's alphas for the scale at Time 1, Time 2, and Time 3 were .76, .76, and .79, respectively. Responses across the six items were summed and coded such that higher scores indicate better sleep quality (i.e. less sleep problems).

Sleep duration (week and weekend): Sleep duration was calculated from participants' sleep-wake times, separately for the week and weekend. Participants were asked to indicate what time they "normally fall asleep" and "normally wake up". Higher scores indicate longer sleep duration.

Intrapersonal adjustment: To assess intrapersonal adjustment a composite variable was computed, which was comprised of three scales: **i) Depressive symptoms:** the Center for Epidemiological Depression Scale (CES-D; Radloff, 1977) was used to assess the degree of depressive symptoms individuals had experienced over the past 2 weeks (e.g., "I thought my life had been a failure"). Responses ranged from *1 = none of the time (less than 1 day)* to *5 = most of the time (10-14 days)*. One sleep item ("My sleep was restless") was excluded from all analyses so as not to inflate the correlations between depressive symptoms and sleep quality. Cronbach's alphas at Time 1, Time 2, and Time 3 were .91, .93, and .93, respectively. **ii) Daily hassles**: Participants indicated the extent to which they felt bothered by twenty-five hassles relating to peers, family, school, and money (e.g., "Not having enough time"). Responses ranged from *1 = almost never bothers me* to *3 = often bothers me*. Cronbach's alphas at Time 1, Time 2, and Time 3 were .84, .84, and .85, respectively. **iii) Self-esteem:** the 10-item Rosenberg Self-Esteem

Scale (Rosenberg, 1965) was used to assess participants' self-esteem (e.g., "I take a positive attitude toward myself"). Responses ranged from *1 = strongly agree* to *5 = strongly disagree*. Cronbach's alphas at Time 1, Time 2, and Time 3 were .90, .92, and .91, respectively. Results of a principal components factor analysis indicated that the three scales hung together as one factor (with factor loadings ranging from .78 to .89 at Time 1, .77 to .89 at Time 2, and .76 to .90 at Time 3. Scores were standardized and averaged across the three variables to form the intrapersonal adjustment composite variable. Scores on the individual scales were coded such that higher scores indicate better intrapersonal functioning.

Friendship quality: assessed using the 18-item Peer Attachment subscale of the Inventory of Parent and Peer Attachment (Armsden & Greenberg, 1987); e.g. "I can count on my friends when I need to get something off my chest". Responses were based on a 4-point Likert scale ranging from *1 = almost always or always* to *4 = almost never or never*. Responses were coded such that higher mean scores indicated more positive friendship quality.

Academic Achievement: Overall year-end academic grades across all courses were accessed from the university's Registrar's Office with permission granted from the participants (only n = 19, 2% of students did not consent to having their grades accessed).

Results

Descriptive Statistics

Descriptives for all variables are presented in Table 1. The proportion of students who met the ISI cut-off for clinical (severe/moderate) insomnia at year 1, 2, and 3 were 16.3%, 16.7% and 17%, respectively. In terms of sleep *duration*, average sleep across the

three years ranged from 7 hours, 54 minutes to 8 hours, 18 minutes during the week; and 8 hours, 36 minutes to 8 hours, 54 minutes on the weekends. At all three assessments, students reported getting significantly more sleep on the weekends relative to the week ($p < .001$).

Results of a Multivariate Analysis of Variance (MANOVA) indicated a significant main effect of gender at all three assessments (all p's <.001). Males reported significantly better intrapersonal adjustment relative to females ($p's < .01$), whereas females reported better friendship quality than males ($p's < .001$) across all three years of university. Males also reported better sleep quality than females at Time 1 ($p < .001$) and Time 2 ($p = .037$) but not at Time 3 ($p = .177$). No significant gender differences were found with respect to academic grades at Time 1 but at Time 2 ($p = .001$) and Time 3 ($p < .001$) females reported significantly higher academic achievement than males. Across all three waves, males and females did not differ with respect to sleep duration during the week and weekend.

Primary Analyses

The primary statistical analyses were carried out using path analysis in AMOS 20.0. Overall model fit was evaluated using the comparative fit index (CFI) and the root mean squared error of approximation (RMSEA, Bentler 1995). As recommended by Hu and Bentler (1999), CFI values greater than .95 and RMSEA's less than .06 (simultaneously) were used as the criteria for a well-specified or close-fitting model. The overall model comprised six variables: sleep quality, sleep duration (week and weekend), intrapersonal adjustment, friendship quality, and academic achievement. Across the three time periods, we included lag-1 cross-lag paths, lag-1 and lag-2 auto-regressive paths,

and concurrent associations between sleep quality and each of the three adjustment variables, as well as between sleep duration (week and weekend) and the three adjustment variables. We included age, gender, and parental education as covariates, with correlations specified between the covariates and each variable at Time 1, and paths estimated between the covariates and each variable at Times 2 and 3. Any significant paths, therefore, would be accounting for the correlations among the variables within a wave, and controlling for previous scores on the outcome variables, covariates, as well as the other predictors in the model.

Results of a chi-square difference test of relative fit indicated that the patterns of associations among the variables were invariant across time, χ^2_{diff} (30) = 24.49, p = > .05. Thus, all subsequent analyses of our research questions were based on the model which was constrained over time, as this was the more parsimonious model. As the pattern of associations was invariant across time, the regression coefficients presented below refer only to results from Time 1 to Time 2 (the pattern of results are the same from Time 2 to Time 3).

Sleep and intrapersonal adjustment

As hypothesized, results indicated a significant bidirectional association between sleep *quality* and intrapersonal adjustment: better intrapersonal adjustment significantly predicted better sleep quality over time, controlling for previous sleep quality, β = .129, *SE* = .136, p < .001; and in turn, better sleep quality significantly predicted better intrapersonal adjustment over time, controlling for previous intrapersonal adjustment, β = .049, *SE* = .004, p = .027. In contrast, results indicated no significant paths between sleep *duration* (week and weekend) and intrapersonal adjustment.

Sleep and friendship quality

Results indicated that better friendship quality significantly predicted better sleep *quality* over time, controlling for previous sleep quality, β = .046, *SE* = .202, *p* = .046, but sleep quality did not predict friendship quality over time, β = .031, *SE* = .003, *p* = .237, supporting our unidirectional hypothesis. In addition, there were no significant associations between sleep *duration* (week and weekend) and friendship quality.

Sleep and academic achievement

A significant unidirectional association was found between sleep *quality* and academic achievement, such that higher academic achievement predicted better sleep quality over time, controlling for previous sleep quality, β = .056, *SE* = .009, *p* = .009, but sleep quality did not predict academic achievement, over time, β = .030, *SE* = .047, *p* = .156. Higher academic achievement significantly predicted shorter sleep *duration* during the week, controlling for previous sleep duration during the week, β = -.073, *SE* = .004, *p* = .001. Academic achievement, however, did not predict sleep duration during the weekend and neither sleep duration during the week nor sleep duration on the weekend predicted academic grades over time.

Gender as a moderator

There were no significant differences in the pattern of findings as a function of gender, χ^2_{diff} (30) = 30.79, *p* > .05.

Discussion

The present study is the first three-year longitudinal study to examine bidirectional associations between sleep (quality and duration) and psychosocial functioning (intrapersonal adjustment, friendship quality, and academic achievement)

among emerging adults at university. Overall, we found that intrapersonal adjustment, friendship quality, and academic achievement were all unique predictors of sleep *quality* over time. In turn, sleep quality only predicted one of the three psychosocial indicators (i.e., intrapersonal adjustment). Another important finding was that psychosocial functioning was more strongly associated with sleep quality than with sleep duration. Participants in our sample generally reported good sleep quality - less than 17% were classified as meeting clinical levels of poor sleep quality across the three assessments, consistent with figures reported in other university samples (Buboltz et al., 2001). At the same time, prevalence rates of chronic poor sleep quality in other samples of university students have been as low as 10% (Fernández-Mendoza et al., 2009) or as high as 54% (Cheng et al., 2012). These discrepant rates might be due to differences in how sleep quality has been operationalized, ranging from single-item measures requiring participants to rate the severity of their sleep problems (Ban & Lee, 2001) to multi-item insomnia scales (e.g., Carney et al., 2006).

We found a significant bidirectional association between sleep *quality* and intrapersonal adjustment over time; more negative intrapersonal adjustment predicted more sleep problems and, in turn, more sleep problems predicted more negative intrapersonal adjustment. According to Riemann and colleagues' (2010) neurocognitive model of insomnia, both cognitive-behavioral (e.g., worry, rumination), as well as neurobiological (e.g., physiological state of hyperarousal) factors, interact to maintain chronic levels of poor sleep quality (see also Espie's, 2002 psychobiological model of good sleep). Furthermore, sleep has been shown to be necessary for emotion regulation due to its role in enhancing the functional connectivity between the medial prefrontal

cortex and the amygdala (Yoo, Gujar, Hu, Jolesz, & Walker, 2007). Reduced connectivity is thought to lead to a state of hyper-arousal, which is characteristic of individuals who report negative intrapersonal adjustment such as mood disorders (Yoo et al., 2007). In turn, heightened physiological arousal also may hinder sleep quality because a state of psychological and physiological rest is necessary for the initiation and maintenance of good sleep quality (Espie, 2002). A vicious cycle, therefore, seems to exist between poor sleep quality and daytime intrapersonal adjustment (Harvey, 2002).

Interestingly, although many researchers propose that sleep *duration* is a necessary resource for psychosocial functioning (Gaultney, 2010; Hamilton et al., 2007; Yoo et al., 2007), we found no association between sleep duration and intrapersonal adjustment. This finding is consistent with results from other studies (Galambos et al., 2009; Pilcher et al., 1997), where authors also found that sleep duration was a weaker predictor of psychosocial adjustment relative to sleep quality. Research on total sleep deprivation, however, indicates that sleep deprived individuals (i.e., those who get zero sleep duration across a specific time frame e.g., 36 hours) report more negative intrapersonal adjustment relative to non-sleep deprived individuals (Minkel et al., 2012). It is possible that these findings may be due to a threshold effect, such that the association between sleep duration and intrapersonal adjustment matters only when individuals are experiencing inadequate sleep. These findings highlight the need for researchers to clearly distinguish the role of total sleep deprivation within experimental contexts versus the role of subjective sleep duration, as it seems that these two constructs are qualitatively different and may exert different influences on intrapersonal adjustment.

It should be noted that average sleep duration reported in the present study was somewhat higher than that of other studies (e.g., Ban & Lee, 2001; Galambos et al., 2013; Gilbert & Weaver, 2010). One reason for this discrepant finding may be differences in how sleep duration is measured across studies. As was done in the present study, some authors base their assessments of sleep duration from participants' sleep-wake times (Galambos et al., 2009), whereas others ask participants to directly estimate the number of hours spent asleep (Ban & Lee, 2001; Galambos et al., 2010). Importantly, Buboltz and colleagues (2001) found a significant difference between sleep duration as assessed from participants' sleep-wake times (8 hours, 2 minutes) and sleep duration as assessed by participants' estimation of the number of hours of sleep they usually get (6 hours, 55 minutes) within the same study. Moreover, whereas some authors distinguish between sleep duration during the *week* and sleep duration during the *weekend* (Buboltz et al., 2001), others do not make this distinction (Ban & Lee, 2001; Galambos et al., 2009). Among our sample, participants reported getting, on average, at least eight hours of sleep across the three assessments - the ideal sleep duration for emerging adults (Lund et al., 2010). Perhaps a different pattern of results would ensue between sleep duration and intrapersonal adjustment within the context of a clinical sample reporting severe sleep restriction.

In terms of the link between sleep quality and interpersonal relationships, our results indicated a unidirectional association: better friendship quality predicted better sleep quality over time, but in turn sleep quality did not predict friendship quality. Our results are in keeping with past researchers' interpretations of concurrent findings linking good sleep quality and positive interpersonal relationships (Fortunato & Harsh, 2006;

Jackowska et al., 2011; Smith et al., 2010). Galambos and colleagues (2010) found that students reported better sleep quality during the months when they reported more frequent socializing with their friends. The authors suggest that healthy friendships may provide an opportune context for the experience of positive emotions, which may facilitate better sleep quality. We were able to test this line of reasoning in the present study by assessing whether there was a significant indirect association between friendship quality and sleep quality through intrapersonal adjustment. Indeed, the indirect association was significant, providing support for the view that intrapersonal adjustment is one mechanism through which high quality interpersonal relationships are associated with better sleep quality.

Furthermore, we found that higher academic achievement predicted better sleep quality over time but not vice versa. One reason for this finding might be due to differences in personality. Individuals who report higher levels of conscientiousness, for example, report higher academic achievement (Gray & Watson, 2002). Individuals who report higher levels of conscientiousness may exert more self-discipline in multiple aspects of their lives, including sleep patterns (Gray & Watson). In fact, lower academic achievement has been associated with more irregular sleep-wake patterns (Gaultney, 2010) and later bed times (Galambos et al., 2013; Singleton & Wolfson, 2009). As such, higher academic performance may foster better sleep practices, which in turn may lead to better sleep quality.

In addition to the direct effect between academic achievement and sleep quality, we also found that higher academic achievement predicted better intrapersonal adjustment over time and better intrapersonal adjustment predicted better sleep quality over time.

These findings suggest that in addition to the direct effect between academic achievement and sleep quality, there also might be an indirect effect between academic achievement and sleep quality through intrapersonal adjustment. We tested this hypothesis and found a significant indirect effect, such that lower academic grades predicted more negative intrapersonal adjustment, which in turn predicted poorer sleep quality. Thus, intrapersonal adjustment may be an important mechanism linking academic achievement to sleep quality.

Academic achievement also significantly predicted shorter sleep duration during the week. These results suggest that high academic achievers may choose to sleep less in order to study for longer periods of time. Galambos and colleagues (2009) found that students who reported spending more time doing school work during the day reported shorter sleep duration that night. It is important to note that although higher academic achievement predicted shorter sleep duration during the week, higher academic achievement was also significantly predictive of better overall sleep quality. Additionally, sleep duration during the week was not associated with overall sleep quality. These findings suggest that compromised sleep duration during the week does not appear to affect students' overall quality of sleep. Importantly, in the present study, among the three psychosocial indicators (intrapersonal adjustment, friendship quality, and academic achievement), academic achievement was the only variable that predicted both sleep quality and sleep duration (during the week). Academic achievement, therefore, remains an important factor to consider in addressing sleep problems among this population. Lastly, although we found some significant differences between males and females on

some of the study measures, gender was not a significant moderator of the overall pattern of results.

Limitations and Directions for Future Research

Findings of the present study should be interpreted in light of the following limitations. First, although we included both sleep quality and duration we did not assess other important sleep variables such as circadian preference, sleep-wake regularity, and sleep onset latency. Future studies should explore the role of these sleep variables in relation to the pattern of results found in the present study. It also would be worthwhile to explore these associations among clinical populations such as those with insomnia and various sleep disorders. One specific avenue for future research would be to employ a person-centered approach to examine whether various subgroups of individuals based on a number of these sleep variables differ with respect to their psychosocial functioning across university. A second limitation concerns the fact that our measure of interpersonal functioning was solely based on friendship quality. Future research should explore the unique role of other forms of interpersonal relationships (e.g., parental attachment) in relation to sleep quality and duration. Third, all measures were based on self-report data (with the exception of academic grades, which were accessed through the Registrar's Office), and therefore represent individuals' subjective perceptions of their sleep and psychosocial functioning. Future research should determine whether the patterns of associations found in the present study are replicated with objective sleep measures (e.g. actigraph recordings). It also should be noted that findings from the present study were based on a sample of university students from one university, which may not be generalizable to all university students or all emerging adults. Future research should

examine the pattern of results found in the present study with diverse populations including high school students, emerging adults who do not attend university, older adults, and the elderly.

Strengths

The present study addressed an important gap in the literature by employing the use of a long-term longitudinal design to examine bidirectional associations between sleep and three indices of psychosocial adjustment among emerging adults at university. Moreover, both sleep quality and sleep duration were investigated. We also employed a comprehensive set of psychosocial adjustment variables (i.e., intrapersonal adjustment, friendship quality, and academic achievement) that have been used to index important developmental tasks among emerging adults at university and our large sample comprised individuals across a number of different academic majors. Finally, our statistical analyses was based on a conservative model, which controlled for previous scores on all outcome measures, as well as important covariates, and also accounted for covariances within each time assessment.

In conclusion, any attempt to address sleep problems among emerging adults at university will need also to address various indices of psychosocial functioning. Overall, our results provide valuable information that will equip students, parents, and university administration with knowledge that will be useful in assisting students in managing their sleep, intrapersonal adjustment, friendships, and academics as they navigate their university years.

Table 2-1

Correlations, Means, and Standard Deviations for Key Study Variables Across the First Three Years of University

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. SLEEP1	-																	
2. SLEEP2	.57	-																
3. SLEEP3	.52	.63	-															
4. SD-wk1	.27	.18	.16	-														
5. SD-wk2	.18	.28	.20	.38	-													
6. SD-wk3	.18	.22	.29	.37	.45	-												
7. SD-wd1	.13	.09	.09	.33	.17	.15	-											
8. SD-wd2	.11	.12	.09	.19	.28	.19	.44	-										
9. SD-wd3	.11	.13	.15	.15	.19	.34	.34	.45	-									
10. INTRA1	.52	.40	.38	.20	.13	.14	.16	.09	.10	-								
11. INTRA2	.38	.52	.45	.14	.16	.15	.11	.07	.09	.67	-							
12. INTRA3	.37	.43	.54	.13	.13	.17	.10	.07	.16	.64	.72	-						
13. FQ1	.16	.18	.18	.08	.08	.08	.07	.08	.08	.37	.30	.30	-					
14. FQ2	.13	.22	.23	.04	.12	.10	.02	.05	.09	.24	.41	.35	.51	-				
15. FQ3	.12	.18	.24	.04	.06	.12	.03	.03	.06	.23	.30	.40	.49	.48	-			
16. ACA1	.05	.09	.10	-.09	-.09	-.09	.00	.02	.03	.09	.11	.12	.03	.04	.04	-		
17. ACA2	.05	.12	.13	-.07	-.06	-.09	.01	.00	.04	.06	.13	.14	.07	.09	.07	.72	-	
18. ACA3	.04	.11	.17	-.06	-.06	-.07	.01	.02	.08	.05	.11	.18	.08	.10	.12	.65	.73	-
M	21.19	20.84	21.08	8.28	7.92	7.97	8.89	8.69	8.57	.00*	.00*	.00*	3.24	3.21	3.21	68.90	69.33	72.10
SD	4.25	4.20	4.42	1.50	1.54	1.47	1.43	1.41	1.37	0.84	0.85	0.84	0.47	0.54	0.52	9.62	9.37	10.20

Note. SLEEP = sleep quality, SD-wk = sleep duration (week), SD-wd = Sleep duration (weekend) INTRA = intrapersonal adjustment, FQ = friendship quality, ACA = academic achievement. Higher scores indicate better sleep quality, longer sleep duration, better intrapersonal adjustment, better friendship quality, and higher academic achievement. Numbers 1, 2, 3 indicate Time 1, Time 2, and Time 3, respectively. M = means, SD = standard deviations. * Means are based on standardized scores of the three variables which make up the composite of intrapersonal adjustment (depressive symptoms, daily hassles, and self-esteem).

Table 2-2

Means, Standard Deviations, Range, and Reliability for all Study Variables

	M (*SD*)	Range	α
Sleep quality1	21.19 (4.25)	7 – 29	0.76
Sleep quality2	20.84 (4.20)	6 - 29	0.76
Sleep quality3	21.08 (4.42)	6 - 29	0.79
Sleep duration (week)1	8.28 hrs (1.50)	4 – 13 hrs	-
Sleep duration (week)2	7.92 hrs (1.54)	2 – 13.50 hrs	-
Sleep duration (week)3	8.00 hrs (1.47)	3 – 12 hrs	-
Sleep duration (weekend)1	8.89 hrs (1.43)	3 – 15 hrs	-
Sleep duration (weekend)2	8.70 hrs (1.42)	2 – 13 hrs	-
Sleep duration (weekend)3	8.57 hrs (1.37)	3 – 13 hrs	-
Intrapersonal adjustment1	0.00* (0.84)	-	-
Intrapersonal adjustment2	0.00* (0.85)	-	-
Intrapersonal adjustment3	0.00* (0.84)	-	-
Friendship quality1	3.24 (0.47)	1.61 - 4	0.89
Friendship quality2	3.21 (0.54)	1.22 - 4	0.91
Friendship quality3	3.21 (0.52)	1.06 - 4	0.92
Academic achievement1	68.90 (9.62)	25 – 93.50	-
Academic achievement2	69.33 (9.37)	28.20 – 89.90	-
Academic achievement3	72.10 (10.20)	10.14 – 91.80	-
Age	19.01 (0.90)	17.17 – 25.51	-
Gender	71.5% female	-	-
Parental education	3.68 (1.29)	1 - 6	-

Note. * Means are based on standardized scores of the three variables which make up the composite of intrapersonal adjustment (depressive symptoms, daily hassles, and self-esteem). Subscripts 1, 2, 3, indicate Year 1, Year 2, and Year 3, respectively.

Table 2-3

Beta Weights (Unstandardized and Standardized) and Standard Errors for all Time 1 to Time 2 Beta Cross Lagged Paths

Path	B	β	SE	*p*
SLEEP 1→ SD-week 2	.027	.075	.010	.007
SLEEP 1→ SD-weekend 2	.017	.049	.009	.076
SLEEP 1→ INTRA 2	.010	.049	.004	.027
SLEEP 1→ FRIEND 2	.004	.031	.003	.237
SLEEP 1→ ACA 2	.066	.030	.047	.156
SD-week 1→ SLEEP 2	.058	.021	.064	.362
SD-week 1→ SD-weekend 2	.043	.045	.024	.067
SD-week 1→ INTRA 2	.000	.000	.011	.992
SD-week 1→ FRIEND 2	-.004	-.012	.008	.621
SD-week 1→ ACA 2	-.089	-.014	.118	.451
SD-weekend 1→ SLEEP 2	-.004	-.001	.065	.955
SD-weekend1→ SD-week 2	.046	.043	.026	.074
SD-weekend1→ INTRA 2	.004	.006	.011	.754
SD-weekend1→ FRIEND 2	-.007	-.018	.009	.421
SD-weekend 1→ ACA 2	.060	.009	.120	.619
INTRA 1→ SLEEP 2	.643	.129	.136	.000
INTRA 1→ SD-week 2	.044	.024	.054	.414
INTRA 1→ SD-weekend 2	-.023	-.014	.050	.649
INTRA 1→ FRIEND 2	.068	.107	.018	.000
INTRA 1→ ACA 2	.013	.001	.252	.960
FRIEND 1→ SLEEP 2	.403	.046	.202	.046
FRIEND 1→ SD-week 2	.066	.020	.080	.409
FRIEND 1→ SD-weekend 2	.122	.041	.075	.103
FRIEND 1→ INTRA 2	.104	.059	.035	.003
FRIEND 1→ ACA 2	.304	.015	.377	.419
ACA 1→ SLEEP 2	.024	.056	.009	.009
ACA 1→ SD-week 2	-.012	-.073	.004	.001
ACA 1→ SD-weekend 2	.004	.025	.003	.280
ACA 1→ INTRA 2	.004	.046	.002	.012
ACA 1→ FRIEND 2	.000	.000	.001	.994

Note. SLEEP = sleep quality, SD-week = sleep duration (week), SD-weekend = Sleep duration (weekend), INTRA = intrapersonal adjustment, FRIEND = friendship quality, ACA = academic achievement. Higher scores indicate: better sleep quality, longer sleep duration, better intrapersonal adjustment, better friendship quality, and higher academic achievement. Numbers 1 and 2 indicate Time 1 and Time 2, respectively.

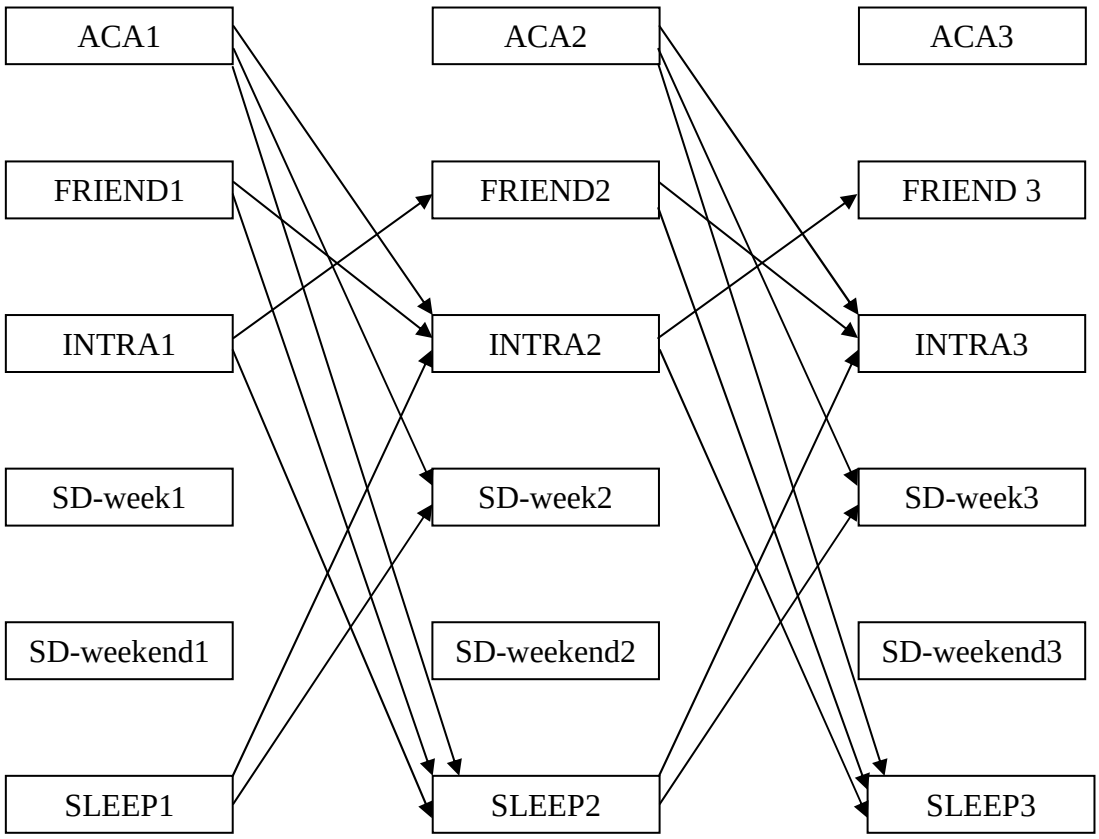

Figure 2-1. Significant cross-lagged paths

Note. SLEEP = sleep quality, SD-week = sleep duration (week), SD-weekend = Sleep duration (weekend) INTRA = intrapersonal adjustment, FRIEND = friendship quality, ACA = academic achievement. Higher scores indicate: better sleep quality, longer sleep duration, better intrapersonal adjustment, better friendship quality, and higher grades. Numbers 1 and 2 indicate Time 1 and Time 2, respectively.

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Chapter 3 (Study 2): Sleep Problems: Predictor or Outcome of Media Use among Emerging Adults at University?[2]

Introduction

In 2010, over 75% of Canadians and Americans (Statistics Canada, 2010a; U.S Census Bureau, 2010) reported having Internet access in their homes. Among adolescents, prevalence rates of daily television and computer use are as high as 85% and 95%, respectively (Milde-Busch et al., 2010). Moreover, 72% of all Internet users report using online social networking (Brenner, 2013). These high prevalence rates have led to increased concern that media use may be displacing important lifestyle behaviours, such as sleep (Zimmerman, 2008). This is an important issue, given the pivotal role that sleep is thought to play in psychosocial functioning across the lifespan (Galambos et al., 2009).

Higher media use consistently is associated with more irregular sleep patterns and shorter sleep duration, as well as more sleep problems (Chahal et al., 2012; Choi et al., 2009; Oka et al., 2008; Punamäki et al., 2007). Researchers have proposed that increased media use may be linked to poor sleep because time spent engaged in media use may directly displace sleep (Li et al., 2006; Oka et al., 2008; Owens et al., 1999; Van den Bulck, 2004; Zimmerman, 2008). Highly arousing media content (e.g., a violent movie) also may lead to nightmares and poor overall sleep quality (Li et al., 2006; Owens, et al.,

[2] A version of this chapter has been published. Tavernier, R., & Willoughby, T. (2014). Sleep problems: Predictor or outcome of media use among emerging adults at university?. *Journal of Sleep Research* (First published online). DOI: 10.1111/jsr.12132

1999; Zimmerman, 2008), particularly among individuals whose emotion regulation strategies are not yet fully developed.

There are two important gaps, however, within the literature: i) a lack of studies examining bidirectional associations between sleep and media use and ii) a lack of studies examining these associations among emerging adults. Researchers generally have inferred that longer media use precedes poor sleep, but have based this interpretation on concurrent measurements (Chahal et al., 2012; Punamäki, et al., 2007; Wang et al., 2012) and thus are not able to determine whether poor sleep, in fact, may precede media use or whether the nature of the association is bidirectional (but see Johnson et al., 2004, for an exception). Poor sleep may predict increased media use over time, for example, as individuals with sleep problems (who generally have been found to report more negative emotional adjustment) may seek out media as a way to cope. In fact, negative emotional adjustment has been linked to media use in both children and older adults (Chen & Kennedy, 2005; van der Goot et al., 2012). Additionally, given that technological advances have led to increased ease of accessing media (e.g., through cell phones; Jacobsen & Forste, 2011), poor sleep quality also may lead to greater media use over time as individuals now can more easily engage in media use when they have difficulty initiating or maintaining sleep (Kubey, 1986).

Furthermore, studies examining the link between sleep and media use have largely been based on children and adolescents (Chahal et al., 2012; Choi et al., 2009; Li et al., 2006; Oka et al., 2008; Van den Bulck, 2004), while little attention has been paid to emerging adults. Importantly, university students have been found to report higher prevalence rates of media use relative to both junior and senior high school adolescents

(Wang et al., 2012). Moreover, in both Canada (Statistics Canada, 2010b) and the U.S (U.S Census Bureau, 2010), use of online social networking has been found to be most prevalent among emerging adults, relative to any other age group. As an extension of the literature, therefore, the purpose of the present three-year longitudinal study was to examine whether both sleep duration and sleep problems would be predictors or outcomes of two forms of media use (i.e., television and online social networking) among a sample of emerging adults.

Method

Participants

Participants were 942 (71.5% female) first year university students at Time 1 (17-25 years; Mean age = 19.01, *SD* = 0.90), who were enrolled at a mid-sized university in Southern Ontario, Canada across three consecutive academic years. Parental education was used as a proxy for socioeconomic status and averaged between "some college, university, or apprenticeship program" and "completed a college/apprenticeship and/or technical diploma." The majority of participants were domestic-Canadian (88%).

Procedure

We recruited first-year university students from various academic disciplines to participate in a longitudinal survey study on stress, coping, and adjustment to university by way of posters, classroom announcements, website postings, and visits to on-campus student residences. Participants were given either 1-hour course credit or monetary compensation (CAD $10.00) at Time 1, and monetary compensation at Time 2 (CAD $20.00), and Time 3 (CAD $30.00). Two follow-up assessments were conducted, each one year apart between. At each assessment, measures were completed between January

and March of the winter school term. The study received ethics clearance by the University Research Ethics Board prior to survey administration at all three assessments, and participants provided informed active consent prior to participation.

Missing Data Analysis

Missing data occurred within each assessment time point because some students did not finish the entire questionnaire (average missing data = 1.5%). In addition, not all participants completed each of the three survey waves - that is, some participants completed the survey in Years 1 and 3, and others completed the survey in Years 1 and 2. Of the original sample that completed the survey in Year 1, n = 713 (63%) completed the survey at all three assessments. However, 82% of the original sample completed at least 2 of the 3 assessments. Missing data analyses revealed that the probability of missingness on a given variable was not related to scores on that particular variable (i.e., data were missing at random; Enders, 2010) and thus missing data for the main model were estimated using the full information maximum likelihood (FIML) estimation method. FIML retains cases that have missing data, thus avoiding the biased parameter estimates that can occur with pair-wise or list-wise deletion (Schafer & Graham, 2002)

Measures

Demographics: age, gender, and parental education were assessed at Time 1, and were used as covariates in the model. For parental education, scores (*1 = did not finish high school* to *6 = professional degree*, r = .40) were averaged for participants who reported on both parents.

Sleep problems: An adapted version of the Insomnia Severity Index (ISI; Morin, 1993) was used to assess severity of sleep problems. Specifically, one item was added:

"Problems staying awake" and two items were deleted: i) "How noticeable to others do you think your sleep problem is in terms of impairing the quality of your life?" and ii) "How worried/distressed are you about your current sleep problem?" Thus participants were asked to rate the severity with which they experienced: difficulty falling asleep, staying asleep, waking up too early, and staying awake; with responses ranging from *1 = no problem* to *5 = very severe problems*. An assessment of participants' overall satisfaction with their subjective sleep quality, as well as perceived daytime functioning as a result of sleep patterns, also were included in the sleep problems index. Scores were summed across the six items and coded such that higher sum scores indicate more sleep problems.

Sleep duration: Sleep duration was calculated from participants' bed times ("What time do you normally fall asleep?") and wake times ("What time do you normally wake up?"), averaged across the week and weekend. Higher scores indicate longer sleep duration (in hours).

Media use: Two indices of media use were assessed: **i) Television:** a) "On an average *week day*, how many hours do you spend watching TV shows/movies either on TV or computer?" b) "On an average *day on the weekend*, how many hours do you spend watching TV shows/movies either on TV or computer?" **ii) Online social networking:** a) "On an average *week day*, how many hours do you spend going on Facebook/My Space/Twitter/E-mail/Messenger?" b) "On an average *day on the weekend*, how many hours do you spend going on Facebook/My Space/Twitter/E-mail/Messenger?" Responses to these four items ranged from *1 = not at all* to *5 = 5 or more hours.* Two separate composite scores were created (i.e., for TV and for online social networking)

based on scores averaged across the week and weekend. Higher scores indicate longer media use.

Plan of Analyses

The primary statistical analyses were carried out using path analysis in AMOS 20.0. Model fit was evaluated using the comparative fit index (CFI) and the root mean squared error of approximation (RMSEA). CFI values greater than .95 and a RMSEA value of less than .06 (simultaneously) were used as the criteria for determining a well-specified or close-fitting model (Hu & Bentler, 1999). We note that both media use variables (i.e., time spent watching television and time spent engaged in online social networking) were modeled as continuous variables instead of categorical variables, as this approach was in keeping with the research question at hand (i.e., an examination of the nature of the association between media use and sleep quality and not on how the specific amount of time spent engaged in media use relates to sleep quality). Descriptive analyses (e.g., histograms; skewness and kurtosis values) indicated that scores on the two media use variables were normally distributed.

The overall cross-lagged model was comprised of four variables assessed at three time points: sleep problems, sleep duration, time spent watching television, and online social networking. Across the three time points we included lag-1 cross-lag paths as well as lag-1 and lag-2 autoregressive/stability paths. We also accounted for concurrent associations among all the study variables within each wave. Age, gender, and parental education were included as covariates, with correlations specified between these three covariates and each of the four variables assessed at Time 1. Finally, paths were

estimated between each covariate and each of the four variables assessed at Time 2 and Time 3.

Results

Descriptive Statistics

Descriptive statistics (i.e., means, standard deviations, ranges, and Cronbach's alpha values) for all study variables are presented in Table 1. Average sleep problems for the sample ranged from 13.81 to 14.16, suggesting that participants reported few sleep problems across the three assessments. Average sleep duration ranged from 8 hours, 18 minutes to 8 hours, 36 minutes, across the three assessments. Overall, participants reported spending, on average, between '1-2 hours' and '3-4 hours' a day on both online social networking and watching television across all three assessments.

Primary Analyses

In terms of the main cross-lagged model, results of a chi-square difference test of relative fit, $\chi^2_{\text{diff}}(12) = 11.75$, $p > .05$, indicated that the patterns of associations among the variables were the same from Time 1 to Time 2 and from Time 2 to Time 3. Thus, subsequent analyses of our research questions were based on the model which was constrained over time and we report below only the regression coefficients for Time 1 to Time 2 (note that the pattern of results among the variables is the same from Time 2 to Time 3). Results of the path analysis indicated that the associations between sleep duration and television, as well as between sleep duration and online social networking were not statistically significant (see Table 2). The associations between sleep problems and television, as well as between sleep problems and online social networking, however, were both statistically significant, such that more sleep problems predicted both longer

time spent watching television, $\beta = 0.070$, $p = .005$, as well as more time spent engaged in online social networking, $\beta = 0.054$, $p = .013$ (see Figure 1), but not vice versa. Both time spent watching TV and online social networking did not predict sleep duration and sleep problems.

Discussion

As an important extension of the literature the present three-year longitudinal study was the first to examine the direction of effects between two important sleep characteristics (i.e., sleep duration and sleep problems) and two indices of media use (i.e., television and online social networking) among a sample of emerging adults at university. In the present study sleep problems predicted both time spent watching television as well as time spent on social networking websites. On the other hand, neither time spent watching television nor time spent on social networking websites predicted sleep problems. Thus, sleep problems was a predictor and not an outcome of media use among our sample of emerging adults. Contrary to our hypothesis, sleep duration was not associated with time spent watching television or engaged in online social networking over time. These results provide important insight into the nature of the associations between sleep and media use among emerging adults at university.

In contrast to findings in the present study, theoretical models of sleep and media use have traditionally modeled sleep problems as the outcome of media use (e.g., Cain & Gradisar, 2010). Moreover, few studies have specifically examined the direction of effects between sleep problems and media use (but see Johnson et al., 2004), particularly among emerging adults at university. The unidirectional finding from sleep to time spent watching television in the present study is in contrast to Johnson and colleagues' (2004)

study, who found that time spent watching television predicted more sleep problems over time but sleep problems did not predict time spent watching television. One reason for this discrepant finding is that Johnson and colleagues assessed the association between watching television in adolescence and subsequent sleep problems in emerging adulthood, whereas the present study assessed the association between watching television and sleep problems *within* the emerging adulthood period. As has been proposed by Johnson et al., perhaps the nature of the association between television and sleep problems changes across the lifespan. It may be that media use exerts a significant effect on sleep quality particularly during adolescence because during this life stage adolescents have not yet fully developed emotion regulation skills. Some media content, for example, may lead to increased arousal, which in turn, may hinder the initiation and maintenance of good sleep. In later life stages, such as emerging adulthood, individuals may be better able to regulate their emotional responses to media content. Indeed, Johnson and colleagues (2004) found that a reduction in time spent watching television at 14 years was associated with a reduced risk for sleep problems at 16 years but interestingly, a reduction in the amount of time spent watching television at 16 years was *not* associated with a reduced risk for sleep problems at 22 years. Also the data for the Johnson study was collected between1983 and 1993 – a period of time when the ease of accessing television other than from a television set was not as prevalent as it is today (Brown, 2006). The current ease of accessing television (e.g., through mobile devices such as iPads and tablets) may have facilitated the use of television as a sleep aid as it has become easier to watch television in the bedroom.

Higher media use (both watching TV and online social networking) may be one way in which emerging adults cope with sleep problems. Indeed, Eggermont and Van den Bulck (2006) found that 36.7% of individuals surveyed reported that they watched television specifically as a way to help them fall asleep. Given that sleep problems have been associated with negative affect (Galambos et al., 2009) and poor overall emotional adjustment (Tavernier & Willoughby, 2013), emerging adults who report more sleep problems may seek out media as a coping mechanism to help regulate their emotions (e.g., Chen & Kennedy, 2005; van der Goot et al., 2012). Additionally, as an activity that requires little physical and mental effort, both television viewing (Kubey, 1986), as well as passive browsing on online social networking websites (Tosun, 2012), are prime candidates for individuals with sleep problems (e.g., difficulty falling asleep) wishing to fill in their time spent trying to fall asleep.

Importantly, in the present study, sleep problems at one point in time predicted longer time spent on media use one year later. This long-term association between sleep quality and media use lends itself to intriguing questions regarding possible mechanisms (e.g., emotion regulation) that may explain this link. Furthermore, given that findings from the present study differ from other studies with regard to the direction of effects between sleep quality and media use (e.g., longer media use was associated with an increased risk of developing sleep problems one year later in Thomée et al., 2012), it is critical that future studies explore possible factors (e.g., personality traits such as neuroticism, conscientiousness) that might moderate the link between sleep characteristics and media use.

Moreover, in contrast to studies with children and adolescents that have reported a link between sleep duration and media use, we found that sleep duration was unrelated to television or online social networking among our sample of emerging adults. First, it is important to note the relatively adequate sleep duration reported among our sample (i.e., more than eight hours of sleep per night across all three assessments). As class start times have been shown to be predictive of sleep-wake timing among university students, increased flexibility in selecting class schedules may facilitate longer sleep duration among emerging adults at university (Onyper et al., 2012). Although past studies have found that shorter sleep duration is associated with longer media use, some of these studies did not assess sleep problems (e.g., Chahal et al., 2012; Oka et al., 2008; Van den Bulck, 2004). Past studies based on emerging adults that have assessed both sleep duration and sleep problems often have found that sleep duration tends to be a weaker predictor of psychosocial outcomes relative to sleep problems (e.g., Galambos et al., 2009).

Although the present study makes a significant contribution to the literature by addressing two important gaps, findings must be interpreted against the study's limitations. First, our measure of online social networking was based on time spent across a number of different social networking websites, lumped together (e.g., Facebook/MySpace/Twitter). As these websites have slightly different components (e.g., options for video chat), we were not able to distinguish *how* individuals spent their time. Additionally, our measure of television use did not assess the content of television programs. Future research should examine, therefore, the direction of effects between sleep problems and time spent on particular activities on social networking websites, and

should include an assessment of television content (e.g., degree of violence). Second, our assessments of television and online social networking were based on only two items per type of media activity. Future research should verify the associations found in the present study using multi-item, validated scales of media use in order to account for different aspects of media use (e.g., social context of media use – whether alone or with friends) and how they might relate to sleep characteristics.

Third, our assessment of sleep problems and sleep duration was based on participants' subjective self-reports. A worthwhile avenue for future research would be to assess the associations found in the present study using objective sleep measures (e.g., actigraph recordings). Fourth, it must be noted that although our sample was comprised of both domestic-Canadian and international students from a variety of different ethnic backgrounds, these students all came from the same university and thus results of our study may not be generalizable to other samples. Importantly, given the increased flexibility that university students have in scheduling sleep-wake timing and daytime activities (Zimmermann, 2011), participants in this sample may not be representative of emerging adults in general, including those who are not enrolled at university and have full-time jobs with different scheduling constraints. Thus, it would be worthwhile for future studies to examine the nature of the association between sleep and media use among non-university emerging adult samples. Fifth, as the present study was based on a select sample of university students who generally reported few sleep problems and adequate sleep duration, it is crucial that future studies also examine the nature of the association between sleep and media use among clinical samples, including individuals diagnosed with insomnia. Sixth, although findings in the present study support a

unidirectional association from sleep to media use, it remains to be determined whether the nature of the association between these two constructs may be reversed (i.e., from media use to sleep), or possibly bidirectional, given a different sample – such as clinically sleep deprived individuals or individuals diagnosed with Internet addiction.

A final noteworthy point concerns the fact that the effect sizes (i.e., standardized beta weights) reported in the present study are deemed "small" by traditional standards (e.g., Cohen, 1992). Nevertheless, it is important to highlight that a strength of the present study was the use of a conservative model, which controlled for autoregressive/stability paths, associations among all variables within a wave, as well as the effect of age, gender, and parental education, while also simultaneously controlling for the effect of the other predictors in the model. Importantly, the present study has addressed two important gaps in the literature: i) the need to assess bidirectional associations between sleep and media use and ii) the need to examine these associations among emerging adults. Our results provide evidence for a unidirectional association between sleep problems and media use, such that more sleep problems predicted both time spent watching TV and engaged in online social networking. Sleep problems, therefore, was the predictor and not the outcome of media use among this sample.

Establishing the direction of effects between sleep problems and media use holds important implications for the effective design and execution of intervention programs aimed at targeting both sleep and waking behaviours among university students. Our findings indicate that it may be worthwhile to promote more effective sleep habits to assist university students in getting good quality sleep, given the pivotal role that sleep plays across the lifespan. As an extension of these findings, it will be imperative for

future research to examine whether or not media use may be effective in assisting university students cope with their sleep problems.

Table 3-1
Correlations, Means, Standard Deviations, Scale Ranges, and Cronbach's alpha values for all Key Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. SPROB1	-														
2. SPROB2	.57	-													
3. SPROB3	.53	.63	-												
4. SDUR1	-.24	-.16	-.14	-											
5. SDUR2	-.19	-.25	-.18	.46	-										
6. SDUR3	-.17	-.22	-.27	.39	.48	-									
7. OSN1	.08	.07	.06	.02	.02	.01	-								
8. OSN2	.12	.10	.10	-.01	.02	.00	.54	-							
9. OSN3	.12	.13	.14	-.02	-.01	-.04	.48	.57	-						
10. TV1	.03	.06	.05	.05	.03	.02	.26	.18	.16	-					
11. TV2	.08	.10	.11	.04	.06	.03	.16	.28	.20	.37	-				
12. TV3	.08	.12	.14	.02	.04	.07	.15	.21	.24	.35	.46	-			
13. AGE	.02	.00	-.01	-.05	-.07	-.06	-.08	-.06	.03	-.02	-.09	-.05	-		
14. GEN	.18	.09	.06	-.05	.00	-.02	.21	.22	.20	.03	.04	.09	-.07	-	
15. PEDU	-.12	-.07	-.06	-.01	.01	.06	-.03	-.09	-.04	-.06	-.01	.01	-.11	-.12	-
M	13.81	14.16	13.92	8.60	8.31	8.27	3.47	3.29	3.20	3.28	3.29	3.24	19.01	1.72	3.68
SD	4.26	4.20	4.42	1.22	1.19	1.17	0.97	0.98	0.93	0.98	1.00	1.05	0.90	0.45	1.29
Range	6-28	6-29	6-29	4-15	4-12	4-12	1-5	1-5	1-5	1-5	1-5	1-5	17-25	1-2	1-6
α	0.76	0.76	0.79	n/a	n/a	n/a	0.85	0.85	0.82	0.74	0.79	0.80	n/a	n/a	n/a

Note. SPROB = sleep problems, SDUR = sleep duration, OSN = online social networking, TV = television, AGE = age at Time 1, GEN = gender, PEDU = parental education at Time1. Numbers 1, 2, and 3 represent Time 1, Time 2, and Time 3, respectively.

Table 3-2

Beta Weights and Standard Errors for all Cross-lagged and Stability Paths

Path	B	*β*	SE	*p*
Sleep problems1 → Sleep problems2	.561	.565	.031	.000
Sleep problems1 →Sleep duration2	-.024	-.088	.007	.000
Sleep problems1 → Online social networking 2	.012	.054	.005	.013
Sleep problems1 →Television2	.017	.070	.006	.005
Sleep duration1 → Sleep duration2	.423	.435	.032	.000
Sleep duration1 → Sleep problems2	-.090	-.026	.077	.240
Sleep duration1 → Online social networking 2	-.004	-.006	.017	.799
Sleep duration1 → Televison2	.023	.028	.021	.259
Online social networking1 → Online social networking 2	.508	.505	.031	.000
Online social networking1 → Sleep problems2	.101	.023	.097	.298
Online social networking1 → Sleep duration2	.003	.003	.029	.909
Online social networking1 → Television2	.058	.057	.026	.025
Television1 → Television2	.361	.356	.034	.000
Television1 → Sleep problems2	.153	.036	.094	.104
Television1 → Sleep duration2	.006	.005	.028	.839
Television1 → Online social networking2	.044	.045	.021	.038

Note. B = Unstandardized beta, *β* = Standardized beta, SE = standard error. Numbers 1 and 2 after variable names indicate Time 1 and Time 2, respectively – only two time points are shown as cross-lagged paths were invariant across the three waves. Results for covariates (age, gender, and parental education) are not shown but can be obtained from first author.

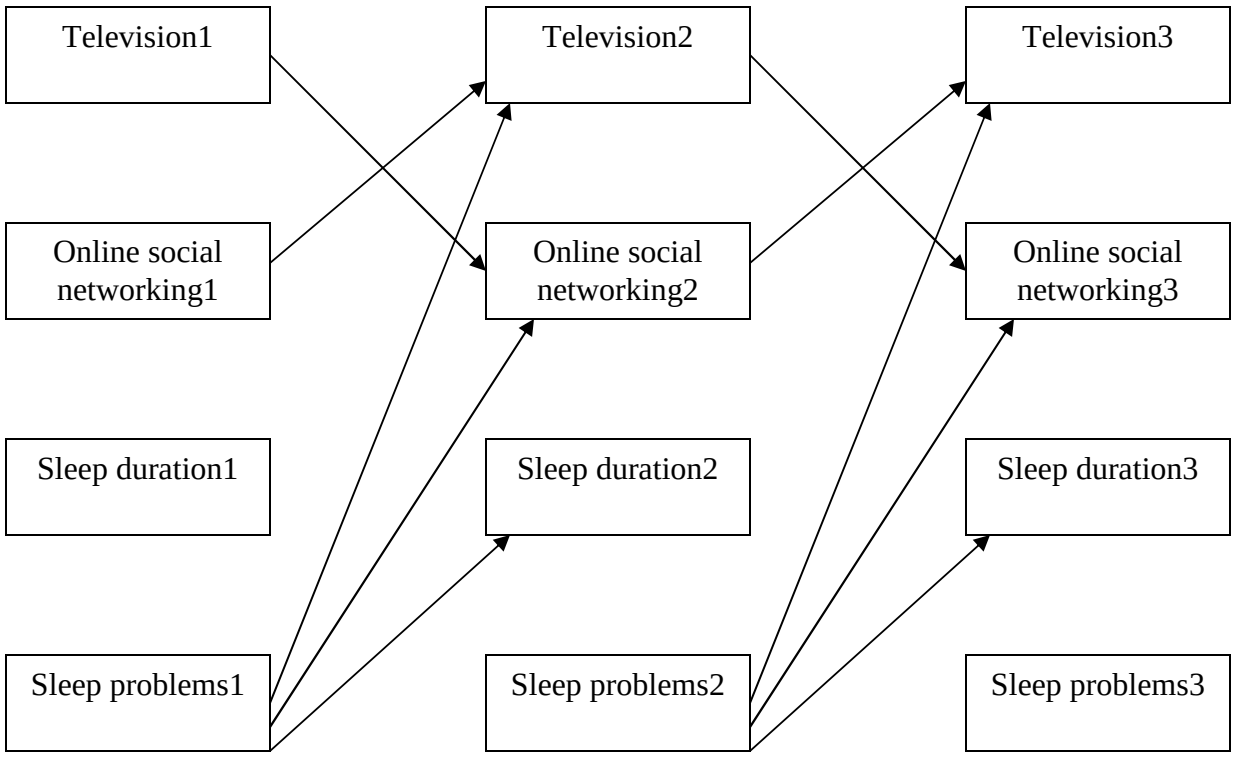

Figure 3-1. Significant cross-lagged paths

Note. Not shown are the stability paths for each of the four variables over time, all of which were significant. Numbers 1, 2, and 3, after variable names indicate Time 1, Time2, and Time 3, respectively. Results for covariates (age, gender, and parental education) are not shown but can be obtained from first author.

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Chapter 4 (Study 3): A Longitudinal Examination of the Bidirectional Association between Sleep Problems and Social Ties at University: The Mediating Role of Emotion Regulation[3]

Introduction

In a seminal review article on the importance of interpersonal relationships, Baumeister and Leary (1995) proposed the *belongingness hypothesis,* which states that human beings have an intrinsic need to establish and maintain close social ties. 'Social ties', as a construct, generally has been used to denote the extent and/or quality of an individual's interpersonal connectedness with others (Thoits, 2011). Developmental researchers have long posited that the formation of social ties with peers is an important developmental life task (Erikson, 1968; Havinghurst, 1972), and that the accomplishment of this life task is believed to positively impact psychosocial adjustment across the lifespan (Roisman, Masten, Coatsworth, & Tellegen, 2004). Importantly, findings within the health literature provide empirical support for these theoretical paradigms. Studies have consistently shown that individuals who report more positive social ties tend to live healthier, happier, longer, and more fulfilling lives relative to individuals with poor social ties (Berkman & Syme, 1979; Cohen, Doyle, Skoner, & Gwaltney, 1997; Eom et al., 2013; House, Landis, & Umberson, 1988; Puyat, 2013). More recently, researchers have

[3] A version of this chapter has been published. Tavernier, R., & Willoughby, T. (2014). A Longitudinal Examination of the Bidirectional Association between Sleep Problems and Social Ties at University: The Mediating Role of Emotion Regulation. *Journal of Youth and Adolescence* (First published online). DOI: 10.1007/s10964-014-0107-x

begun to explore the role of social ties in relation to one particularly important human behavior – sleep.

A growing body of research indicates that individuals' sleep quality is significantly linked to the quality of their social ties (e.g., Cacioppo et al., 2002). Given the role that sleep quality plays in overall psychosocial adjustment across the lifespan (e.g., Alapin et al., 2000; Ohayon, 2002; Segrin & Domschke, 2011), it is imperative that researchers specifically examine *how* social ties relate to sleep quality. A first step would be to determine the direction of effects between social ties and sleep quality. Second, it is necessary to examine the mechanisms through which social ties and sleep quality are associated by assessing possible mediators of this association. Research addressing the direction of effects, as well as the mechanisms linking social ties and sleep quality, however, is lacking as the majority of studies that have examined this link have been based on concurrent data. Yet, addressing these empirical questions is important particularly for individuals as they transition from adolescence to emerging adulthood.

Within Western cultures, emerging adulthood (approximately 18 – 25 years of age) refers to a distinct period of life between adolescence and adulthood, which is generally characterized by higher levels of autonomy relative to adolescence, but fewer responsibilities relative to adulthood (Arnett, 2007). For this reason, emerging adults – particularly those at university – may have increased autonomy in setting their sleep-wake patterns (Zimmermann, 2011). Thus, sleep characteristics assessed among this population are less likely to be directly influenced by parents and more likely to reflect the individual's own sleep preferences (Orzech, Salafsky, & Hamilton, 2011). Furthermore, unlike high school where class start times tend to be fixed from day-to-day,

university students have some flexibility in selecting class schedules, which may have important implications for sleep-wake patterns and overall sleep quality (Onyper, Thacher, Gilbert, Gradess, 2012).

Moreover, for emerging adults at university, an important aspect of their overall adjustment is the establishment of new friendships at university. In one study based on over 1,800 university students across six Canadian universities, Buote and colleagues (2007) found that higher friendship quality (based on new friendships established at university) significantly predicted more positive academic, social, personal-emotional, and institutional adjustment. These findings are particularly salient given the proposition that social ties - particularly those with like-others (e.g., those who share similar lived experiences) – are hypothesized to be most fulfilling and effective for overall adjustment through the exchange of *empathetic understanding* (Thoits, 1986). Given that emerging adults at university report profound negative changes in their high-school friendships (e.g., become more distant) during the first year of university (Oswald & Clark, 2003), and that new friendships at university are strongly predictive of overall university adjustment (Buote et al., 2007), we chose to focus our assessment of social ties on the quality of individuals' social networks specific to the university setting. First, we review the research findings on sleep problems in relation to social ties. Then we present an overview of the research on sleep problems and social ties in relation to emotional well-being in order to support our proposed hypothesis that emotion regulation may be one mechanism linking sleep problems and social ties.

Sleep Problems and Social Ties

Poor sleep quality has been significantly associated with lower levels of social support, higher levels of interpersonal conflict, and higher levels of loneliness (Cacioppo et al., 2002; Fortunato & Harsh, 2006; Segrin & Domschke, 2011). In general, individuals who report more negative social ties tend to report more sleep problems (Aanes, Hetland, Pallesen, & Mittelmark, 2011; Ailshire & Burgard, 2011; Friedman et al., 2005). For example, Howell, Digdon, Buro and Sheptycki (2008) found that higher social well being (e.g., social integration) was significantly correlated with better overall sleep quality among university students. Additionally, Cacioppo and colleagues consistently have found a significant concurrent main effect of loneliness on sleep quality, such that lonely individuals tend to report poorer sleep quality relative to non-lonely individuals (e.g., Cacioppo et al., 2002). Despite the rich body of research linking sleep problems and social ties, however, the majority of studies assessing this link have been based on concurrent data. Researchers, therefore, have been unable to specifically examine the direction of effects between these two constructs. In other words, do positive social ties predict better sleep quality or does better sleep quality predict more positive social ties? Alternatively, is the relationship between these two constructs bidirectional?

Some researchers, nonetheless, have inferred a unidirectional association and suggested that negative social ties precede poor sleep - this interpretation is based on the proposition that close, fulfilling interpersonal relationships may provide a context for the experience of positive emotions, which in turn may facilitate better sleep quality (e.g., Aanes et al., 2011; Segrin & Domschke, 2011). There is evidence to suggest, however, that the nature of the association between sleep problems and social ties may, in fact, be bidirectional.

Specifically, Garde and colleagues (2012) found a bidirectional association between social ties and sleep quality among a sample of working adults, although this finding was significant only when sleep quality was assessed as an index of difficulties with awakening (e.g., feeling exhausted at awakening), but not when sleep quality was assessed as an index of disturbed sleep (e.g., difficulties falling asleep). In other words, more sleep problems (based on difficulty with awakenings) significantly predicted reports of more problems with work colleagues and family members, and in turn, more problems with work colleagues and family members predicted more difficulties with awakenings. Garde and colleagues (2012) suggested that this bidirectional association could be explained through elevated levels of psychological arousal that hinder cognitive and affective functioning, which are necessary for both sleep quality and interpersonal interactions with others. Importantly, as the authors conducted their study across a 3-day period, the nature of the association between sleep problems and social ties remains to be determined within the context of a long-term longitudinal study. Furthermore, given that Garde and colleagues (2012) conducted their study with a sample of working adults, it is necessary to examine the nature of the association between social ties and sleep quality among a sample of emerging adults at university whose sleep-wake patterns may be qualitatively different from that of working adults.

Moreover, some authors have assessed the quality of social ties very broadly, based on an aggregate across different domains, including parents, friends, neighbors, and intimate partners (e.g., Aanes et al., 2011; Orzech et al., 2011). Although some studies have specifically focused on isolating the quality of social ties within a specific domain, such as cohabitating intimate partners (Hasler & Troxel, 2010), work colleagues

(e.g., Nakata et al., 2004), or family members (Ailshire & Burgard, 2012), no studies to date have specifically focused on examining sleep problems in relation to social ties specific to the university setting. Examining how sleep quality relates to social ties at university in particular, has important implications as social ties specific to the university setting may include relationships with roommates/ housemate, who may directly affect an individual's sleep quality (e.g., noisy roommates) (Orzech et al., 2011; Shaikh & Deschamps, 2006).

Emotion Regulation as Mediator

Although a significant concurrent link between sleep problems and social ties has been well established within the literature, research examining the mechanisms through which these two constructs are associated is limited (Aanes et al., 2011; Zawadzki, Graham, and Gerin; 2013). Given that past research has found that emotional well-being is significantly associated with both social ties (e.g., Howell et al., 2008) and sleep problems (e.g., Ohayon, 2002), we propose that emotion regulation may be one mechanism linking social ties and sleep quality.

Embedded within a functionalist perspective (which posits that emotions are a direct product of the interaction between an individual and his/her environment), emotion regulation refers to the various strategies that an individual employs to monitor, assess, and alter one's reaction to a situation in order to achieve a desired goal (Campos, Mumme, Kermoian, & Campos, 1994). According to Baglioni et al (2010), difficulties with emotion regulation can influence the level of an individual's emotional reactivity, which may subsequently give rise to a number internalizing and externalizing problem behaviours. Thus, to support the hypothesis that emotion regulation may play a mediating

role in the link between sleep problems, we draw on studies that have assessed various facets of overall emotional well-being, including variables such as depressive symptoms, anxiety, and perceived negative affect.

Evidence from both concurrent and longitudinal studies indicate that higher levels of negative affectivity are significantly associated with poor sleep quality (e.g., Jansson-Fröjmark & Lindblom, 2008; Zawadzki et al., 2013). Among individuals diagnosed with a mood disorder (e.g., depression), for example, up to 80% report insomnia symptoms (Ohayon, 2002), and clinical reports of sleep problems have been shown to predict the onset of depression (see Baglioni, Spiegelhalder, Lombardo, & Riemann, 2009 for a review). Furthermore, among both university students and working adults, higher levels of neuroticism are significantly associated with more sleep problems (Cheng et al., 2012; Soehner, Kennedy, & Monk, 2007).

Notably, models of insomnia have proposed that the nature of the association between emotional well-being and sleep quality may be bidirectional, such that poor emotional well-being would be expected to predict more sleep problems (e.g., difficulty initiating sleep) and, in turn, more sleep problems would be expected to predict poor emotional well-being (e.g., Baglioni et al., 2009). Indeed, longitudinal studies, based on both child and adult samples, have provided some support for this proposed bidirectional hypothesis between sleep quality and negative emotionality (e.g., depression) (Garde et al., 2012; Jansson-Fröjmark & Lindblom, 2008; Kelly & El-Sheikh, 2013).

In addition to being significantly associated with sleep quality, emotional well-being also has been linked to social ties (Heinrich & Gullone, 2006). In a recent study, Zawadzki and colleagues (2013) found that loneliness was a significant concurrent

predictor of both rumination and anxiety, and in turn, rumination and anxiety predicted depressive symptoms among their sample of university students. Among adult workers, perceived support from supervisor, coworkers, and family members were all significantly correlated with lower depressive symptomatology (Nakata et al., 2004), while lower levels of perceived social support were found to predict higher negative affect among a community sample of adults (Brummett et al., 2006). Furthermore, lower levels of perceived social support have been significantly linked to more depressive symptoms, higher levels of stress (Jackson, 2006), higher levels of neuroticism and hostility, and lower levels of positive affect (Pressman et al., 2005). A key aspect of positive social ties, therefore, may be the provision of emotional support (either directly or indirectly), which may facilitate higher levels of emotional well-being among individuals (e.g., Cohen, 2004; Thoits, 1986).

The Present Study

Taken together, the findings reviewed above indicate the following: a) social ties are associated with sleep quality, although the specific direction of effects remains unclear; b) social ties play an important role in emotional well-being; and c) emotional well-being and sleep quality have been found to be mutually associated. These findings suggest that emotion regulation may be one important mechanism linking social ties and sleep quality. Specifically, more positive social ties may facilitate better emotion regulation, and in turn, better emotion regulation may lead to better sleep quality. Moreover, given the evidence of a bidirectional link between emotional well-being and sleep quality, it is left to be determined whether sleep problems might lead to less effective emotion regulation, which in turn, may negatively affect social ties. These

proposed associations have not yet been empirically tested among emerging adults at university within the context of a long-term longitudinal design and thus these associations form the premise of the present study. The purpose of the present 3-year longitudinal study, therefore, was to address two research questions: 1) Is there a significant bidirectional association between sleep problems and social ties at university? and 2) Does emotion regulation mediate the association between sleep problems and social ties at university?

In addressing the nature of the association between sleep problems and social ties, it also was critical to control for the effects of important third variables that have been shown to be associated with sleep quality and/or social ties. Of note, we recognize that 'sleep problems' is a multifaceted construct, which may include a variety of sleep characteristics (e.g., short sleep duration, longer sleep onset, and more irregular sleep-wake timing). For the purposes of the present study, however, we used the term sleep problems to refer to an individuals' subjective perceived quality of his/her sleep experience. Other aspects of sleep, including sleep duration and sleep-wake irregularity were included as covariates in our cross-lagged model (see below). In past studies researchers also have assessed sleep quality based on ratings of problems that include the initiation and maintenance of good sleep (e.g., Buboltz et al., 2001). They also have included assessments of sleep duration, weekend delay, and/or weekend oversleep as distinct (though related) sleep characteristics (e.g., Lund et al., 2010; Pilcher & Ott, 1998; Soehner et al., 2007). Age, gender, and parental education were included as covariates because past studies have reported significant age and gender differences in sleep quality (e.g., Cheng et al., 2012; Tsai & Li, 2004), while reports of family income and

socioeconomic status have been found to differentiate among sleep characteristics of adolescents (McHale, Kim, Kan, & Updegraff, 2011). We also controlled for three important sleep characteristics (i.e., sleep duration, weekend delay, and weekend oversleep), given that past research indicates that shorter sleep duration (Gilbert & Weaver, 2010), and more irregular sleep-wake patterns (Monk Petrie, Hayes, & Kupfer, 1994) have been significantly associated with subjective reports of more sleep problems. In one Canadian sample of university students, socializing with friends was a significant predictor of longer sleep duration that night, but in turn, one additional hour of sleep on a given night was significantly associated with a significant decrease in the likelihood of socializing with friends the next day (Galambos et al., 2009). Additionally, individuals classified as 'poor-sleepers' have been found to report consuming significantly more alcohol per day relative to individuals who were classified as 'optimal-sleepers' (e.g., Lund Reider, Whiting, & Prichard, 2010) and thus, alcohol use also was included as a covariate in the model.

Method

Participants

Participants were 942 (71.5% female) emerging adults who remained enrolled at a mid-sized university in southern Ontario, Canada, across three years. Participants ranged in age from 17 to 25 years (M = 19.01 years, SD = 0.90) at Time 1. The majority (i.e., 88%) of the sample was domestic-Canadian students, some of whom reported British (19%), Italian (16.8%), French (9.5%), and German (9%) ethnic backgrounds. Among the international students, the majority reported being from Asia (36.1%), European Union (15.7%), the Caribbean (10.2%) and Africa (10.2%). Parental education levels

(used as a proxy for socioeconomic status) reported by participants indicated that mean levels of education for mothers and fathers fell between “some college, university, or apprenticeship program” and “completed a college/apprenticeship and/or technical diploma.”

Procedure

We specifically recruited first year university students across a variety of academic disciplines. Potential participants were recruited through visits to on-campus student residences, posters, website postings, as well as classroom announcements, and were invited to participate in a longitudinal survey examining factors related to stress, coping, and overall psychosocial functioning across the university years. Surveys were completed annually for three years and administered by trained research assistants. As an incentive to participate in the study, students received either course credit or monetary compensation (CAD $10.00) at Time 1 and monetary compensation at Time 2 (CAD $20.00) and Time 3 (CAD $30.00). Only students who completed the survey at Time 1 were recruited to participate at Time 2 and 3 (through emails, posters, and classroom announcements). The study received ethics clearance from the University Ethics board prior to survey administration at all three assessments, and all participants provided informed active consent prior to participation.

Missing Data Analysis

For our sample of 942 emerging adults, missing data occurred because participants did not complete the entire questionnaire at each of the three waves (average missing data = 1.5%). Missing data occurred also because not all participants completed the survey at all three waves. Out of the original sample that completed the survey at the

first assessment, *n* = 685 (72.8%) completed all three assessments. However, 90.3% completed at least 2 of the 3 waves. Results of a MANOVA indicated that participants who completed only the first assessment did not significantly differ from participants who completed at least two out of the three waves on age, parental education, sleep problems, social ties, sleep duration, weekend delay, and weekend oversleep at Time 1 (all *p*'s >.05). Individuals who completed only the first wave, however, were more likely to be male (p = .001), consumed more alcohol (*p* = .028), and had less effective emotion regulation (p = .043) at Time 1, relative to participants who completed at least two out of the three waves. Missing data analysis revealed that the probability of missingness on a given variable was not significantly related to any variable scores (i.e., data were missing at random; Enders, 2010). Thus, missing data for the main model were estimated using the full information maximum likelihood (FIML) estimation method. FIML retains cases that have missing data, thus avoiding the biased parameter estimates that can occur with pair-wise or list-wise deletion (Schafer & Graham, 2002).

Measures

With the exception of the demographic variables (i.e., age, gender, and parental education), all variables were assessed at three time points, one year apart. See Table 1 for range of scores and Cronbach's alpha, if applicable.

Demographics: At the first assessment, we assessed participants' age, gender, and parental education (one item per parent, averaged for participants reporting on both parents, with a scale of *1 = did not finish high school* to *6 = professional degree*, *r* = .40).

Sleep problems: Sleep problems were assessed using an adapted version of the Insomnia Severity Index (ISI; Morin, 1993). Specifically, one item was added: "Problems

staying awake" and two items were deleted: i) "How noticeable to others do you think your sleep problem is in terms of impairing the quality of your life?" and ii) "How worried/distressed are you about your current sleep problem?" Thus, participants were instructed to indicate the extent to which they experience: i) Difficulty falling asleep, ii) Difficulty staying asleep, iii) Problem waking up too early, and iv) Problem staying awake. Response options for these four items ranged from *1 = no problem* to *5 = very severe problems*. The fifth item asked: How satisfied are you with your sleep pattern? Response options ranged from *1 = very satisfied* to *5 = very dissatisfied*. The last item asked: To what extent do you think your sleep patterns interfere with your daily functioning (daytime fatigue, ability to function at school or daily tasks, concentration, memory, mood, etc)? Response options ranged from *1 = rarely interferes* to *4 = very often interferes*. Responses to these six items were summed and coded such that higher scores indicate more sleep problems (i.e., poorer sleep quality). High internal consistency coefficients for the ISI have been reported in past studies based on university students in the U.S (Cronbach's $\alpha = 0.85$; see Cukrowicz et al., 2006), a community and clinical sample of older adults in Canada (Cronbach's $\alpha = 0.90$ and 0.91, respectively; see Morin, Belleville, Bélanger, & Ivers, 2011), as well as a sample of adolescents in China (see Chung, Kan, & Yeung, 2011). In terms of convergent validity, the ISI has been shown to be significantly associated with both objective measures of sleep efficiency obtained from polysomnography and sleep diary measures in older adults (Morin et al., 2011), as well as measures of depression and disturbed dreams and nightmares among university students (Cukrowicz et al., 2006).

Social ties: Three items from the social adjustment subscale of the Student Adaptation to College Questionnaire (SACQ; Baker & Siryk, 1989) were used to assess social ties at university: i) I am meeting people and making friends at university; ii) I have several close social ties at university, and iii) I am satisfied with how much I am participating in social activities at university. Responses ranged from *1 = not at all like me* to *5 = completely like me*. Results of a principal components factor analysis with varimax rotation indicated that the three items hung together as one factor, with factor loadings ranging from 0.71 to 0.79 at Time 1, 0.70 to 0.81 at Time 2, and 0.76 to 0.82 at Time 3. Higher mean scores of the three items indicate more positive social ties at university.

Emotion regulation: Emotion regulation was assessed based on a composite of two scales. One scale was *Difficulties with emotion regulation*: We used six items adapted from the Difficulties with Emotion Regulation Scale; (DERS, Gratz & Roemer, 2004). Participants were asked to rate the frequency with which six different emotion regulation strategies was applicable to them (e.g., "When I am upset or stressed, I have difficulty thinking about anything else"). Responses ranged from *1 = Almost never* to *5 = Almost always*. Higher scores indicate more difficulties with emotion regulation. The second scale was *Emotion reactivity:* We assessed emotion reactivity using 13 items from the Emotional Reactivity Scale (ERS; Nock, Wedig, Holmberg, & Hooley, 2008). Participants were asked to rate the extent to which 13 statements reflected their emotional reactions (e.g., When I am angry/ upset, it takes me much longer than most people to calm down"). Responses ranged from *1 = Not at all like me* to *5 = Completely like me*.

Higher scores indicate greater negative emotional reactivity. Scores on these two scales were averaged to form a composite of emotion regulation.

Sleep duration: Sleep duration was calculated from participants' bed times ("What time do you normally fall asleep?") and wake times ("What time do you normally wake up?"), averaged across the week and weekend. Higher scores indicate longer sleep duration (in hours).

Weekend delay: We assessed bedtime weekend delay by calculating the difference in average bed times between the week and the weekend, where higher scores indicate more irregular bed times across the week and weekend.

Weekend oversleep: We assessed weekend oversleep by calculating the difference in average wake times between the week and the weekend, with higher scores indicating more irregular wake times across the week and weekend.

The assessment of weekend delay and weekend oversleep as discrepancies and bed times and wake times, respectively, have been used in past studies to index sleep-wake irregularity (e.g., see Lund et al., 2010; Soehner et al., 2007; Wolfson & Carskadon, 1998).

Alcohol: We assessed both the frequency and amount of alcohol consumed: *i) Frequency:* "How often do you go drinking or have a drink"? Responses ranged from 1 = *Never* to 8 = *Everyday* and *ii) Amount:* "On average, when you are drinking alcohol, about how many drinks do you have"? Responses ranged from 1 = *less than 1 drink* to 6 = *over 10 drinks*. Scores across the two items were standardized and averaged such that higher scores indicate higher alcohol consumption.

Plan of Analyses

The main statistical analyses were conducted using path analysis in AMOS version 20.0. Criteria for model fit were based on the comparative fit index (CFI) and the root mean squared error of approximation (RMSEA), such that a CFI value greater than .95 and a RMSEA value of less than .06 (simultaneously) indicated good fit (Hu & Bentler, 1999). Our analyses were based on two separate path models. The first model was used to assess the bidirectional association between sleep problems and social ties at university. This model was comprised of six variables: (i.e., sleep problems and social ties assessed at three time points, as well as four control variables - sleep duration, weekend delay, weekend oversleep, and alcohol – also assessed at three time points).

The second model, based on the Bootstrap method of indirect effects, was used to test the mediating role of emotion regulation. In bootstrapping, cases from the original dataset are selected randomly (with replacement) in order to generate additional data sets, usually with the same number of cases as the original data set. This is done multiple times (e.g., 2000) in order to resemble the selection of multiple random samples from a given population (Kline, 2011). Using the bootstrapping approach, we examined whether there was a significant indirect path from social ties to sleep problems through emotion regulation, and also, whether there was a significant indirect path from sleep problems to social ties through emotion regulation. Thus, this second model was comprised of three variables: sleep problems, emotion regulation, and social ties. Furthermore, in this model, we also tested whether there was a bidirectional association between sleep problems and emotion regulation.

For both models, we included lag-1 cross-lag paths as well as lag-1 and lag-2 autoregressive paths for all study variables that were assessed at the three time points. We

also accounted for concurrent associations among the study variables within a wave by specifying correlations between the error terms. Correlations also were specified between Time 1 covariates (age, gender, and parental education) and all study variables assessed at Time 1. Finally, for both models, paths were estimated from age, gender, and parental education to each study variable assessed at Time 2 and Time 3.

Results

Table 1 shows descriptive statistics (e.g., means and standard deviations) for all study variables. Across the three years, participants reported average sleep duration scores ranging from 8 hours and 16 minutes in Year 3 to 8 hours and 36 minutes in Year 1. The means for sleep problems across the 3 years were generally low (ranging from 13.82 in Year 1 to 14.16 in Year 2 (on a 6-29 scale, with higher scores indicating more sleep problems or lower sleep quality). Finally, stability paths for sleep problems were relatively highly stable over time (with standardized beta coefficients ranging from .47 from Time 2 to Time 3 to .56 from Time 1 to Time 2).

Research question1: Is there a significant bidirectional association between sleep problems and social ties at university?

In order to assess model fit for the first model, we compared a cross-lagged model (see plan of analyses section above) where the paths were constrained across the three waves, [χ^2 (60) = 71.07, p = .155; RMSEA = .014, 95% CI (.000, .025), CFI = .998], to a cross-lagged model where paths were unconstrained (i.e., free to vary) over time, [χ^2 (30) = 32.65, p = .338, RMSEA = .010, 95% CI (.000, .027), CFI = .999]. Results of a chi-square difference test of relative fit indicated that the unconstrained model did not provide a significantly better fit to the data compared to the constrained model, χ^2_{diff} (30)

= 38.42, p = > .05; suggesting that the pattern of associations among the variables was invariant across the three waves. Thus, our analysis of this research question was based on the constrained model as this was the more parsimonious model. As the pattern of associations was invariant across time, the regression coefficients presented below (as well as the coefficients presented in Table 2) refer only to results from Time 1 to Time 2 (i.e., the pattern of results are the same from Time 2 to Time 3). As shown in Table 2, results of path analysis indicated that there was a significant bidirectional association between sleep problems and social ties at university, such that more sleep problems significantly predicted less positive social ties over time, β = -.053, SE = .005, p = .026, and in turn, less positive social ties at university significantly predicted more sleep problems over time, β = -.060, SE = .101, p = .006.

Research question 2: Does emotion regulation mediate the association between sleep problems and social ties at university?

To assess the potential mediating role of emotion regulation between social ties and sleep problems, we tested two separate mediation models (based on a test of indirect effects). Specifically, we assessed whether: i) social ties at university would predict sleep problems through emotion regulation and ii) sleep problems would predict social ties at university through emotion regulation. Bootstrap method analyses for indirect effects indicated a significant indirect path from social ties (at Time 1) to sleep problems (at Time 3) through emotion regulation (at Time 2), β = -.007, SE = .003, p = .002, 95% CI [-.015, -.002], and also a significant indirect path from sleep problems (at Time 1) to social ties (at Time 3) through emotion regulation (at Time 2), β = -.005, SE = .003, p = .017, 95% CI [-.012, -.001].

Secondary analyses

Is there a significant bidirectional association between sleep problems and emotion regulation?

Results from the second model indicated a significant bidirectional association between sleep problems and emotion regulation, such that more sleep problems significantly predicted more negative emotion regulation, $\beta = .044$, $SE = .003$, $p = .035$, and in turn, more negative emotion regulation significantly predicted more sleep problems, over time, $\beta = .107$, $SE = .139$, $p = .000$.

Covariates

In terms of the Time 1 covariates (age, gender, and parental education), results of the cross-lagged path model indicated that being younger, male status, and reports of higher parental education predicted greater alcohol use over time, whereas being younger and female status were significant predictors of more positive social ties over time. The cross-lagged path model also included covariates (sleep duration, weekend delay, weekend oversleep, and alcohol), that were controlled for at each of the three assessments. As can be seen from Figure 1, results indicated that greater alcohol use predicted longer weekend delays, and in turn, longer weekend delays predicted longer weekend oversleep. Both shorter sleep duration and longer weekend oversleep were predicted by more sleep problems. None of these covariates predicted either social ties or sleep problems.

Discussion

Although past studies indicate a significant link between sleep problems and social ties, there remains a dearth of studies examining the direction of effects between

these two constructs. Furthermore, as the majority of studies have been based on concurrent data, researchers have been unable to assess possible mechanisms (i.e., mediators) that may explain the association between sleep problems and social ties within a longitudinal design. The present 3-year longitudinal study was conducted to address these two important gaps in the literature. Results showed a significant bidirectional association between sleep problems and social ties, such that more sleep problems predicted less positive social ties at university, and in turn, less positive social ties at university predicted more sleep problems. Importantly, tests of indirect effects provide evidence for the critical role that emotion regulation plays in explaining this bidirectional association between sleep problems and social ties.

Our results showed that, on the one hand, more positive social ties at university predicted more effective emotion regulation, which in turn, predicted better sleep quality; and also that more sleep problems predicted less effective emotion regulation, which in turn, predicted less positive social ties at university. Cohen consistently has highlighted the important role that positive social ties play in overall emotional functioning (see Cohen, 2004). Individuals who form part of our social networks may facilitate effective emotion regulation both directly (e.g., by providing specific solutions to a problem) or indirectly (e.g., bolstering the individual's psychological and cognitive resources so that they are better equipped to deal with stressors) (Buote et al., 2007; Cohen, 2004; Thoits, 1986). Notably, our assessment of social ties was specific to the university setting. In particular, our measure of social ties was based on participants' subjective reports of the degree of their involvement in social activities at university, as well as the establishment of new friendships with university peers. This approach serves as an important extension

of the literature, as past studies examining social ties and sleep quality have assessed social ties as either social support or relationship quality in general or lumped together across various domains such as friend/family member/partner (e.g., Aanes et al., 2011), as opposed to assessing social ties specifically at university.

For students, our findings suggest that participating in university activities and establishing social ties at university may be beneficial for sleep quality through the facilitation of effective emotion regulation. Importantly, Thoits (1986) stated that support from like-others may prove to be particularly effective in helping individuals cope with stressors through the exchange of empathetic understanding (Thoits, 1986). According to Thoits (1986), these like-others include other individuals who share similar demographic backgrounds and have shared lived experiences. Thus it follows that, university peers who also are transitioning through university and who are experiencing similar challenges (e.g., living away from home, adjusting to class schedules and other academic demands, establishing social networks), may play an instrumental role in students' emotion regulation strategies. Therefore, it may be worthwhile for university housing/residence staff to design programs that facilitate high levels of group interaction so as to increase opportunities for all students to create meaningful social ties (Shaikh & Deschamps, 2006).

Among our sample of emerging adults at university, more difficulties with emotion regulation predicted more sleep problems. This finding was not surprising as past research supports a significant link between emotion regulation and sleep quality (Cheng et al., 2012; Ohayon, 2002; Soehner et al., 2007). Theoretical models of insomnia propose that poor emotion regulation predict more sleep problems through heightened

cortical, cognitive, and physiological arousal (Baglioni et al., 2009; Espie, 2002; Perlis, Giles, Mendelson, Bootzin, & Wyatt, 1997). In one study, for example, Harvey (2000) found that reports of cognitive intrusions (e.g., worries and concerns) were significantly more prevalent among individuals with clinical levels of insomnia compared to controls. Given that a state of de-arousal is optimal for the initiation and maintenance of good sleep quality (Espie, 2002), it follows that such heightened arousal would result in increased sleep problems among individuals (Baglioni et al., 2009).

Moreover, in keeping with past studies (e.g., Tavernier & Willoughby, 2014), results of the present study indicated a significant bidirectional association between sleep problems and emotional well-being such that poor emotion regulation predicted more sleep problems, and, in turn, sleep problems predicted poor emotion regulation over time. Our findings extend past research by demonstrating that poor sleep quality may hinder an individual's ability to establish positive social ties, through compromised emotion regulation skills. Individuals with poor emotion regulation may appear to peers as hostile or neurotic – traits that have been associated with greater negative affect and lower positive affect (Brisette & Cohen, 2002), and thus may not be conducive to participation in group activities. Indeed, findings from qualitative interviews with university students indicate that students perceive poor sleep as having a negative impact on their mood, which in turn, may make it more difficult to establish and maintain social ties with peers (Orzech et al., 2011).

In addition to the significant findings relating to the bidirectional association between sleep problems and social ties, as well as the mediating effect of emotion regulation, the present study also assessed important covariates (sleep duration, weekend

delay, weekend oversleep, and alcohol use) that warrant some discussion. The only significant finding relating to sleep duration was that more sleep problems predicted shorter sleep duration over time. As an extension of past studies that have found a significant concurrent association between sleep problems and sleep duration but have been unable to establish the direction of effects (e.g., Gilbert & Weaver, 2010; Liu & Zhou, 2002), findings from the present study provide support for a unidirectional association between the two constructs. The finding of a significant predictive effect from sleep problems to sleep duration was not surprising, given that our measure of sleep problems included problems such as difficulty initiating and maintaining sleep, which would be expected to negatively interfere with an individual's total time spent asleep. It is important to note that although poor sleep quality predicted shorter sleep duration over time, sleep duration, in turn, did not predict sleep problems. This finding suggests that whereas shortened sleep duration may be one negative consequence of poor sleep quality, shortened sleep duration does not necessarily lead to poorer sleep quality over time.

Notably, participants in the present study reported average sleep duration of more than 8 hours per night, which is comparable to reports of estimated sleep duration in one U.S sample of university students (i.e., 8 hours, 2 minutes during the week and 8 hours, 27 minutes on the weekend; Buboltz et al., 2001), but higher than findings from other studies where reports of sleep duration ranged from 6 hours, 42 minutes to 7 hours and, 12 minutes per night, also among university students (e.g., Ban & Lee, 2001; Galambos et al., 2013; Gilbert & Weaver, 2010). These discrepant findings in sleep duration across studies may be due to methodological differences in how sleep duration was assessed. For example, sleep duration was significantly higher (i.e., 8 hours, 2 minutes) when

calculated from participants' reported sleep-wake times, relative to when participants were directly asked to estimate their daily sleep duration (i.e., 6 hours, 55 minutes) (Buboltz et al., 2001).

Moreover, in the present study, both poor sleep quality, as well as longer weekend delay, predicted longer weekend oversleep, suggesting that sleep problems, as well as discrepancies in bedtimes across the week, interfere with individuals' ability to maintain consistent wake times across the week. Indeed, past research has found that individuals who experience poor sleep quality and adopt irregular bed times may compensate by sleeping in for longer periods of time on the weekends (Jefferson, et al., 2005).

Additionally, our findings indicate that greater alcohol use predicted more inconsistent bed times across the week (i.e., longer weekend delays). This finding was not surprising given that alcohol use is typically considered a night time social activity in North American society (Negriff, Lorah, Pabst, Susman, 2011), particularly among university students (Galambos et al., 2010). Thus it would be expected to interfere with individuals' ability to maintain consistent bed times across the week and weekend. No other predictive effects were found for alcohol use in the present study. Although Lund and colleagues (2010) found a significant mean difference on number of alcohol drinks consumed between university students reporting good versus poor sleep quality, follow-up regression analyses indicated that alcohol use was not a significant predictor of sleep quality among their sample of university students. The non-significant association between alcohol use and sleep problems also has been confirmed in other studies (e.g., Galambos et al., 2010; Orzech et al., 2011), suggesting that alcohol use may not lead to changes in university students' subjective sleep problems over time.

Of note, sleep quality remained highly stable over time, which is consistent with past studies that have employed multiple assessments of sleep quality based on both child (e.g., Kelly & El-Sheikh, 2013) and older adult samples (e.g., Buysse et al., 2008). In the present study, the stability of sleep problems across the first three years of university may be due to stable environmental factors, such as poor sleep hygiene (Buboltz et al., 2002), as well as individual differences in physiological functioning, such as susceptibility to heightened autonomic arousal, which may sustain sleep problems (Espie, 2002).

Despite the present study's contribution to the literature, findings must be interpreted against the study's limitations. First, although we recruited a representative sample of students (e.g., across various academic disciplines and living situations), participants were all drawn from one university and thus findings from the current study may not be generalizable to other populations including emerging adults who are not enrolled at university.

Second, by focusing on the role of social ties specific to the university setting, we excluded social ties from other domains including family members and friends outside of university. Our decision, however, to isolate the role of social ties specific to the university setting in relation to emotional regulation and sleep was based on Thoits' (1986) proposition that social support from like others should prove to be most effective for facilitating optimal emotional regulation because individuals who have shared lived experiences (as in the case of university peers who also are transitioning across university) are able to provide empathetic understanding, which is a key component of social support . Importantly, given that our measure of social ties was based on students' satisfaction with their participation in university activities, as well as their perceived

satisfaction with the establishment of new friendships and close social ties at university, an important extension of the present study would be to specifically assess the types of social support received (e.g., emotional), as well as the actual quality of these social ties. Future studies that specifically assess the quality of students' relational functioning within the context of their university friendships, in relation to emotional functioning and various sleep characteristics, will shed further light on the actual mechanisms linking social ties and emotion regulation.

Third, participants in the present study generally reported few sleep problems and average sleep duration of greater than 8 hours per night. Findings, therefore, may not be generalizable to clinical samples. In fact, an important extension of the current study would be to assess the associations found in the present study with a sample of individuals with clinical levels of sleep problems and chronic sleep deprivation, as well as individuals with clinical levels of internalizing problems, such as depression and/or anxiety. For example, the strength of the associations among social ties, emotion regulation, and sleep problems may be stronger among individuals who are clinically sleep deprived, relative to individuals who report adequate sleep duration.

Fourth, as our assessment of sleep problems was based on participants' subjective reports, it may be worthwhile to explore the associations found in the present study based on objective assessments of sleep problems (e.g., actigraph recordings). Lastly, our assessment of social ties, which also was based on participants' subjective self-reports could have been validated against reports of social ties from peers. Still, we believe that an individual's own subjective assessment of their social ties at university would perhaps provide the most valid assessment. We also note that the effect sizes found in the present

study would be considered ‘small’ relative to traditional standards (e.g., Cohen, 1992). However, we highlight the fact that the use of such a conservative cross-lagged model was a strength of the present study (i.e., controlling for previous scores on the outcome variables as well as other predictors and covariates; accounting for associations among all study variables within a wave; and controlling for Time 1 covariates of age, gender, and parental education).

Conclusion

Taken together, our results emphasize the importance of social ties for sleep quality and, in turn, the importance of sleep quality for social ties. Results of the present study also highlight emotion regulation as one mechanism that may explain the bidirectional link between sleep problems and social ties at university. Positive social ties predicted less sleep problems through effective emotion regulation and, in turn, less sleep problems predicted more positive social ties through effective emotion regulation. Our findings, therefore, suggest that if both students and university administration become more vigilant about adopting a balanced approach in fostering opportunities for the establishment of positive social ties while also maintaining an environment that is conducive to good quality sleep, students may be better equipped to effectively cope with the stressors that are inevitably part of their university experience.

Table 4-1

Descriptive Statistics for all Study Variables

Variable	*M* (*SD*)	Range	*Number of items*	*Cronbach's α*
Age	19.01 (0.90)	17.17 – 25.51	1	n/a
Gender	71.5% female	n/a	1	n/a
Parental education	3.68 (1.29)	1 - 6	2	n/a
Sleep problems1	13.82 (4.26)	6 – 29	6	0.76
Sleep problems2	14.16 (4.20)	6 - 29	6	0.76
Sleep problems3	13.92 (4.42)	6 - 29	6	0.79
Social ties1	3.23 (0.91)	1 – 5	3	0.68
Social ties2	3.20 (0.93)	1 – 5	3	0.73
Social ties3	3.24 (0.97)	1 – 5	3	0.76
Difficulties with emotion regulation1	2.76 (0.76)	1 - 5	6	0.73
Difficulties with emotion regulation2	2.84 (0.76)	1 - 5	6	0.74
Difficulties with emotion regulation3	2.84 (0.76)	1 - 5	6	0.76
Emotion reactivity1	2.18 (0.84)	1 - 5	13	0.93
Emotion reactivity2	2.21 (0.82)	1 - 5	13	0.93
Emotion reactivity3	2.31 (0.86)	1 - 5	13	0.94
Sleep duration1	8.60 (1.22)	4 - 15	4	n/a
Sleep duration2	8.31 (1.19)	4 - 13	4	n/a
Sleep duration3	8.27 (1.17)	4 - 12	4	n/a
Weekend delay1	1.56 (1.14)	-7 - 6	2	n/a
Weekend delay 2	1.57 (1.18)	-4 - 8	2	n/a
Weekend delay 3	1.43 (1.16)	-3 - 6	2	n/a
Weekend oversleep1	2.16 (1.62)	-3 - 8	2	n/a
Weekend oversleep2	2.33 (1.61)	-4 - 9	2	n/a
Weekend oversleep3	2.03 (1.52)	-4 - 8	2	n/a
Alcohol1				
Number	3.82 (1.38)	1 - 6	1	n/a
Frequency	3.69 (1.60)	1 – 8	1	n/a
Alcohol2				
Number	3.95 (1.25)	1 - 6	1	n/a
Frequency	3.64 (1.43)	1 – 8	1	n/a
Alcohol3				
Number	3.81 (1.23)	1 - 6	1	n/a
Frequency	3.44 (1.37)	1 - 8	1	n/a

Note. Numbers 1, 2, and 3 represent Time 1, Time 2, and Time 3, respectively.

Table 4-2

Correlations Among all Key Study Variables Across the First Three Years of University

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. SPRB1	-																			
2. SPRB2	.57	-																		
3. SPRB3	.52	.63	-																	
4. WD1	-.11	-.07	-.06	-																
5. WD2	-.04	-.10	-.06	.38	-															
6. WD3	-.01	-.03	-.07	.25	.42	-														
7. WO1	.07	.05	.04	.28	0.06	.03	-													
8. WO2	.06	.11	.08	.14	.21	.05	.33	-												
9. WO3	.05	.08	.09	.11	.13	.29	.25	.35	-											
10. SD1	-.24	-.16	-.14	.08	.04	.03	.01	0.02	.02	-										
11. SD2	-.19	-.25	-.18	.09	.01	.01	.04	-.10	-.01	.46	-									
12. SD3	-.17	-.21	-.27	.08	.06	.03	.03	.00	-.02	.38	.49	-								
13. SOC1	-.20	-.17	-.15	.11	.07	.05	.01	.01	.01	.12	.11	.11	-							
14. SOC2	-.13	-.18	-.17	.05	.10	.05	.02	.02	.02	.05	.06	.09	.54	-						
15. SOC3	-.13	-.16	-.18	.05	.05	.06	.01	.02	.06	.05	.04	.03	.51	.56	-					
16. ALC1	.03	.04	.04	.32	.34	.32	.06	.06	.06	.11	.08	.08	.17	.08	.08	-				
17. ALC2	.02	.07	.06	.25	.34	.37	.03	.07	.06	.09	.05	.07	.12	.12	.08	.78	-			
18. ALC3	.02	.06	.10	.25	.31	.42	.03	.03	.09	.09	.06	.04	.13	.09	.10	.75	.80	-		
19.ERG1	.42	.33	.32	-.09	-.07	-.06	-.04	.02	.02	-.14	-.09	-.09	-.18	-.16	-.15	-.10	-.11	-.10	-	
20.ERG2	.34	.25	.30	-.08	-.12	-.08	-.03	.04	.03	-.09	-.08	-.07	-.16	-.22	-.19	-.09	-.09	-.10	.68	-
21.ERG3	.30	.26	.27	-.07	-.10	-.08	-.02	.02	-.01	-.08	-.06	-.08	-.16	-.20	-.23	-.09	-.10	-.10	.60	.70

Note. Numbers 1, 2, and 3 indicate Time 1, Time 2, and Time 3 respectively. SPRB = Sleep problems, WD = Weekend delay, WO = Weekend oversleep, SD = Sleep duration, SOC = Social ties, ALC = Alcohol, ERG – Emotion regulation. Higher scores indicate more sleep problems, longer weekend delay, longer weekend oversleep, longer sleep duration, more positive social ties, higher alcohol use, and more difficulties with emotion regulation.

Table 4-3

Beta Weights and Standard Errors for all Time 1 Cross-Lagged and Stability Paths

Path	*B*	*β*	*SE*	*p*
Sleep problems 1 → Sleep problems2	.553	.555	.031	.000
Sleep problems1→ Sleep duration2	-.023	-.084	.007	.000
Sleep problems1 → Weekend delay2	-.003	-.010	.007	.683
Sleep problems1→ Weekend oversleep2	.021	.056	.010	.032
Sleep problems1→ Social ties2	-.012	-.053	.005	.026
Sleep problems1→ Alcohol2	.003	.015	.004	.380
Social ties1 → Social ties2	.553	.522	.032	.000
Social ties1→ Sleep problems2	-.279	-.060	.101	.006
Social ties1→ Sleep duration2	.042	.032	.030	.169
Social ties1→ Weekend delay2	-.017	-.013	.031	.589
Social ties1→ Weekend oversleep2	.016	.009	.044	.716
Social ties1→ Alcohol2	-.008	-.007	.016	.634
Sleep duration1 → Sleep duration2	.422	.433	.032	.000
Sleep duration1 → Sleep problems2	-.073	-.021	.077	.342
Sleep duration1 → Weekend delay2	-.015	-.050	.024	.538
Sleep duration1 → Weekend oversleep2	.030	.023	.033	.361
Sleep duration1 → Social ties2	-.019	-.025	.018	.278
Sleep duration → Alcohol2	.002	.002	.012	.890
Weekend delay1→. Weekend delay2	.327	.311	.036	.000
Weekend delay1 → Sleep problems2	-.054	.014	.086	.531
Weekend delay1→ Sleep duration2	.018	.017	.026	.479
Weekend delay1→ Weekend oversleep2	.077	.055	.037	.037
Weekend delay1→ Social ties2	-.024	-.029	.020	.221
Weekend delay→ Alcohol2	.014	.017	.013	.309
Weekend oversleep1 → Weekend oversleep2	.304	.306	.035	.000
Weekend oversleep1→ Sleep problems2	.032	.012	.058	.583
Weekend oversleep1→ Sleep duration2	.028	.038	.017	.113
Weekend oversleep1→ Weekend delay2	-.032	-.043	.018	.076
Weekend oversleep1→ Social ties2	.014	.025	.013	.278
Weekend oversleep1→ Alcohol2	-.016	-.028	.009	.078
Alcohol1 → Alcohol2	.743	.752	.023	.000
Alcohol1→ Sleep problems2	.155	.034	.107	.146
Alcohol1→ Sleep duration2	.039	.031	.032	.219
Alcohol1→ Weekend delay2	.321	.249	.033	.000
Alcohol1→ Weekend oversleep2	.016	.009	.046	.728
Alcohol1→ Social ties2	.024	.024	.024	.317

Note. *B* = unstandardized beta weights, *β* = standardized beta weights, SE = standard error. Higher scores indicate: more sleep problems, better social ties, longer sleep duration, longer weekend delay and oversleep, and more alcohol consumption. Numbers 1 and 2 indicate Time 1 and Time 2, respectively. Note that because paths were invariant across time, the pattern of results is the same from Time 2 to Time 3 (not shown).

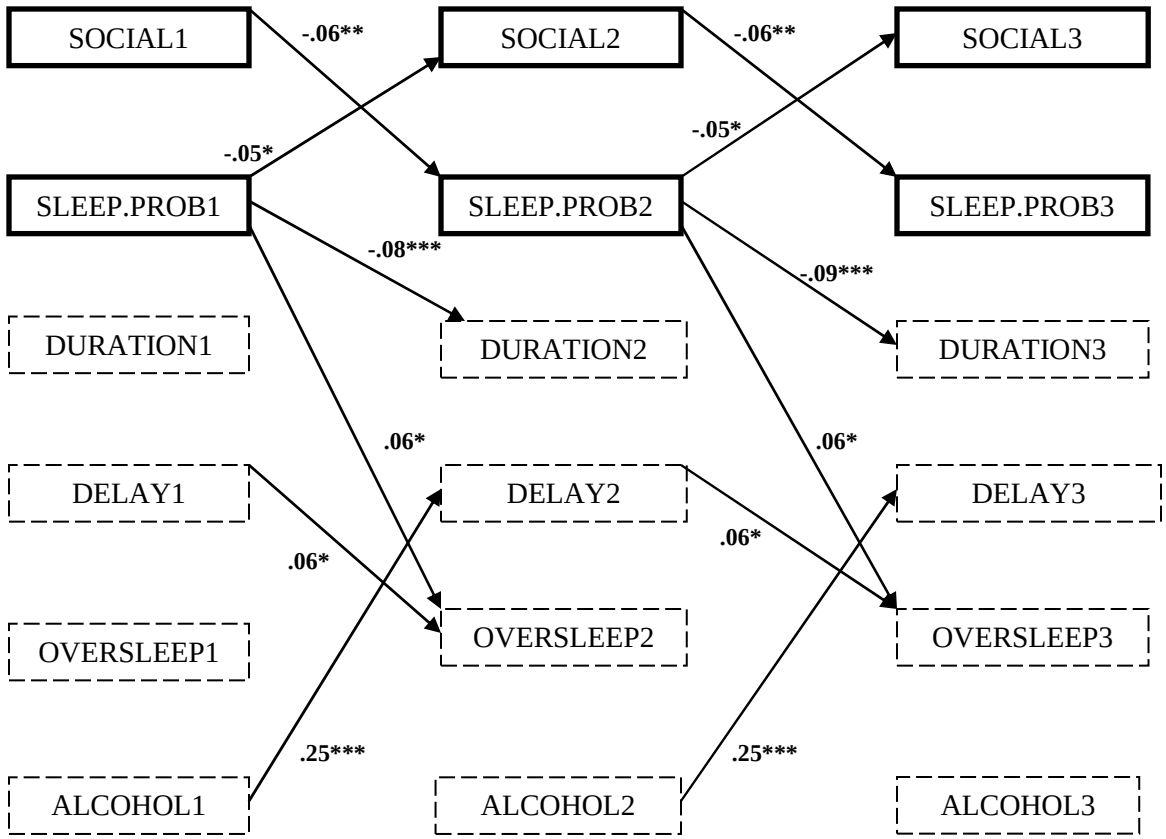

Figure 4-1. Significant cross-lagged paths

Note. * p < .05, ** p < .01, ***p <.001. Values indicate standardized beta weights (unstandardized beta weights along with standard errors are presented in Table 2). SOCIAL = Social ties at university, SLEEP.PROB = Sleep problems, DURATION = Sleep duration, DELAY = Weekend delay, OVERSLEEP = Weekend oversleep, ALCOHOL = Alcohol use. Higher scores indicate: more positive social ties, more sleep problems, longer sleep duration, longer weekend delay, longer weekend oversleep, and higher alcohol consumption. Numbers 1, 2, and 3 indicate Time 1, Time 2, and Time 3, respectively. Covariates are indicated by dashed rectangles. Not shown are the three Time 1 covariates (age, gender, and parental education), results for which may be requested by the first author.

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Chapter 5: General Discussion and Conclusions

The main purpose of my dissertation was to address an important gap in the literature by conducting three longitudinal studies (spanning three years) that examined bidirectional associations between sleep characteristics (e.g., sleep quality, sleep duration) and various indices of psychosocial functioning (e.g., academic achievement, friendship quality, intrapersonal adjustment, media use, social ties at university) among a sample of university students. Given that past research has identified different characteristics of sleep that may be differentially associated with various indices of psychosocial functioning, I examined different aspects of the sleep experience across the three studies; namely, sleep duration, sleep quality, and sleep-wake irregularity. Across the three studies, the use of autoregressive cross-lagged path models allowed for an examination of the temporal ordering of effects between sleep and adjustment variables. Findings across the three studies provide support for the following: 1) bidirectional associations (between sleep quality and intrapersonal adjustment/emotional well-being, as well as between sleep quality and social ties); 2) unidirectional associations with sleep quality as outcome (e.g., friendship quality and academic grades predicted sleep quality, but not vice versa); and 3) unidirectional associations with sleep as predictor (e.g., sleep quality predicted media use, but not vice versa). Each of these patterns of associations will be discussed in turn.

Bidirectional Associations

Findings from Study 1 indicated that there was a significant bidirectional association between sleep *quality* and intrapersonal adjustment (composite measure of depressive symptoms, self-esteem, and daily hassles). Similarly, findings from Study 3

indicated a significant bidirectional association between sleep *quality* and emotion regulation (i.e., composite of emotion reactivity and difficulties with emotion regulation). Thus, both intrapersonal adjustment and emotion regulation share reciprocal effects with participants' subjective reports of their sleep quality. In other words, individuals' insomnia symptoms both affect, and are affected by, individuals' emotional well-being. Our findings are well aligned with theoretical models that have proposed various mechanisms through which emotional adjustment may be mutually linked with sleep quality (Baglioni et al., 2009). According to Riemann and colleagues' (2010) *hyperarousal model of insomnia*, for example, there may be both a cognitive-behavioral and neurobiological pathway linking emotional well-being and sleep quality. More specifically, the authors suggest that, through the cognitive-behavioral domain, participants' appraisal of stressors, coupled with low perceived psychological coping resources may lead to increased worries pertaining to the sleep experience, which in turn, may result in delayed sleep onset as a function of increased arousal. Individuals may experience, therefore, increased difficulty initiating sleep and may spend a significant amount of time awake in bed (Baglioni et al., 2009). Such behavioral conditioning may then lead to feelings of depression and anxiety, and ultimately chronic insomnia, due to the sustained hyperarousal state of the cognitive system (Riemann et al., 2010). The authors suggest that these effects may be reciprocal, such that depression and anxiety may predict increased arousal, which in turn, undermines the individual's coping ability and as a result leads to worries about sleep, feeding back into the cycle of sustained hyperarousal (Riemann et al., 2010).

Although findings of my dissertation have provided evidence that supports a mutual association between sleep quality and emotional well-being, some authors have cautioned against the view that chronic sleep problems are merely a consequence or symptom of poor emotion regulation and specifically differentiate between primary and secondary insomnia (e.g., Espie, 2002). Individuals who report insomnia in the absence of other factors that could account for their symptoms are classified as experiencing primary insomnia; whereas individuals reporting insomnia symptoms in the context of mental disorders, having a medical condition, or being diagnosed with a sleep disorder would be classified as experiencing secondary insomnia (Ohayon, 2002). Although there is significant overlap between insomnia and mental illness (e.g., depression, anxiety), it is necessary to keep in mind that there are subgroups of individuals who experience symptoms in one domain (e.g., insomnia) but not in the other (e.g., mental illness) (Espie, 2000; Ohayon, 2002). Nevertheless, the significant bidirectional association between sleep quality and emotional well-being found in the present study offers insight into the specific *nature of the association* between these two constructs, and provides empirical support for theoretical models of cognitive and neurobiological mediating pathways of sleep and emotional functioning. Findings from the present study, therefore, may inform intervention programs that aim to target both sleep and emotional adjustment behaviors. In particular, among our normative sample of university students, findings suggest that improving the use of effective emotion regulation strategies, and bolstering students' psychological resources (e.g., self-esteem), may be beneficial for their sleep quality. At the same time, improved sleep quality may facilitate better emotional well-being among students.

In addition to the bidirectional association between sleep quality and emotional well-being, findings from the present study provide support for a significant bidirectional association between sleep *quality* and social ties at university (Study 3). Interestingly, however, in terms of the nature of the association between friendship quality and sleep quality (assessed in Study 1), the only significant predictive effect was from friendship quality to sleep quality (but not from sleep quality to friendship quality). Thus, although both friendship quality and social ties at university could be considered indices of interpersonal relational functioning, only social ties at university shared significant reciprocal effects with sleep quality. One reason for this finding could be that social ties at university represent a more proximal measure of students' interpersonal relational functioning - given that the measure of social ties at university was based on items that assessed the extent to which students were making friends and participating in activities *at university*. In contrast, items on the friendship quality measure referred to general friendships, which could have included friendships outside of university. It appears, therefore, that whereas quality of interpersonal relationships consistently affects students' subjective reports of their sleep problems; in turn, sleep quality seems to matter specifically for more proximal interpersonal relationships. This finding is not surprising, given that the individuals who make up students' social ties at university may very well include roommates/housemates/classmates, with whom they would be expected to be in frequent and direct contact. It is possible that individuals' reports of their sleep problems (e.g., difficulty initiating sleep) may be a consequence of their noisy roommates, and thus subjective perceptions of sleep problems may mutually be tied to individuals' experiences with others within their immediate social network.

Of note, evidence from my dissertation provided support for the role of emotional regulation as a mediator of the association between social ties and sleep quality. The ability to provide empirical support for a mechanism that explains the bidirectional association between social ties and sleep is noteworthy because of the potential impact such knowledge has for informing practice. For example, these findings suggest that efforts to improve sleep quality among university students may do well to include strategies that target improving emotional well-being and vice versa. Of course, future research examining additional mechanisms (beyond emotion regulation, as was assessed in Study 3) would provide further insight into how sleep quality impacts individuals' social ties. Taken together, findings of my dissertation highlight the important role that social ties at university play for sleep quality through the facilitation of more effective emotion regulation strategies.

Unidirectional Associations: Sleep as Outcome

The focus on sleep characteristics among university students was premised on a rich body of past literature that highlights the importance of good sleep for overall psychosocial adjustment, such as depressive symptoms and academics (e.g., Gray & Watson, 2002; Howell et al., 2008). Given that the majority of these studies were based on concurrent data, however, it was necessary to specifically examine the direction of effects between sleep and psychosocial functioning variables. Interestingly, findings from Study 1 indicate that both friendship quality and academic achievement (as indexed by year-end averages obtained from the Registrar's Office), were significant predictors of sleep quality. Based on the theory of developmental tasks, individuals must aim to make significant strides towards starting a career, as well as establish close meaningful ties

with others (Havighurst, 1972; Roisman et al., 2004). As such, these two domains of psychosocial functioning - career and interpersonal relationships - directly map unto our assessments of academic achievement and friendship quality, respectively. Given that successful accomplishment of these goals within the emerging adulthood age period is proposed to lead to optimal psychosocial functioning, such as academic success and quality of interpersonal relationships (e.g., Masten et al., 2004), it is not surprising that higher grades and good quality friendships would predict increased sleep quality among university students.

Given the well-established link between sleep quality and emotional well-being (e.g., Baglioni et al., 2009; Garde et al., 2012; Tavernier & Willoughby, 2014) it may be that success in the domains of academics and interpersonal relationships may foster positive emotional well-being, which in turn, may facilitate good sleep quality. In line with this view, results from a study of Canadian university students by Galambos and colleagues (2010) indicated that higher academic effort was significantly associated with lower negative affect, lower perceived stress, and higher positive affect across multiple assessments across students' first year of university. Similarly, more positive interpersonal relationships (e.g., through greater perceived social support and reciprocity) have consistently been linked with lower levels of depression, anxiety and other negative mental states (Chandola et al., 2007; Eom, et al., 2013; Jackson, 2006; Zimet et al., 1988).

It is interesting that findings of my dissertation (Study 1) did not provide evidence that sleep characteristics (i.e., sleep quality and sleep duration) predict academic achievement. It is important, however, to emphasize that among our sample of emerging

adults, subjective reports of the sleep characteristics assessed indicated relatively adequate average levels of sleep duration and generally good sleep quality.

Unidirectional Associations: Sleep as Predictor

An intriguing finding of my dissertation was the significant unidirectional effect found between sleep quality and media use, such that more sleep problems predicted increases in time spent watching television, as well as increases in time spent engaged in online social networking (Study 2). Past research had generally inferred a directional path from media use to poor sleep quality – albeit based mostly on concurrent data (e.g., Chahal et al., 2012; Punamäki, et al., 2007; Wang et al., 2012). Results of my dissertation, therefore, provided an important extension to the literature by specifically assessing the direction of effects between sleep characteristics and media use. With respect to our sample of university students, sleep problems preceded media use, suggesting that the amount of time students spend watching television and engaging in online social networking may be a function of their inability to initiate and maintain sleep. In contrast, our findings found no support for negative implications of media use on sleep quality among our sample. Given the ease of access to media devices (e.g., cell phones, tablets) (Brown, 2006), it is not surprising that sleep problems (which include difficulty falling asleep and staying asleep) would lead to increased time spent engaged in media. With such ease of access, those who are having difficulty falling asleep could easily reach for their cell phones or tablets as a way to occupy their time.

Future research is warranted to determine the specific content of TV programs watched, as well as the types of activities that students are engaged in when accessing social networking sites. What aspects of TV and online social networking are most

appealing to students who experience sleep problems? Furthermore, are there subgroups of students who engage in both TV and online social networking, versus those who are drawn to TV *or* online social networking? Finally, given that the measure of sleep quality assessed six different aspects of sleep problems/insomnia symptoms, it remains to be determined which specific items (e.g., problems waking up too early, problems staying awake, difficulty staying asleep) may be most strongly predictive of time spent engaged in media use.

Limitations and Directions for Future Research

Although university has been noted as a unique context for the study of sleep and psychosocial functioning, a worthwhile extension of my dissertation would be to explore associations between sleep and psychosocial functioning within a different age period. In particular, adolescence also has been identified as an especially sensitive period for the study of sleep and psychosocial functioning for a number of reasons. For example, some of the biological changes that occur during adolescence may have important implications for sleep behaviour, as in the case of the general shift towards an evening-type circadian preference, which is thought to be due to underlying physiological changes that occur during puberty (Crowley, Acebo, Carskadon, 2007; Dahl & Lewin, 2002; Kim, Dueker, Hasher, Goldstein, 2002; Zeiders, Doane, & Adam, 2011). Additionally, increasing academic demands, sustained sleep need of approximately 9.2 hours, coupled with early school start times, all contribute to the uniqueness of the adolescent period for the study of sleep and psychosocial functioning (Dahl & Lewin, 2002; Wolfson & Carskadon, 1998). Of note, in a recent 3-wave study examining bidirectional associations between sleep quality and internalizing behavior problems, Kelly and El-Sheikh (2013) found that

depressive symptoms at Time 1 (*M* age approximately 8 years) predicted poor sleep quality at Time 2 (*M* age approximately 10 years), but sleep quality at Time 1 was not predictive of depressive symptoms at Time 2. Interestingly, however, sleep quality at Time 2 significantly predicted depressive symptoms at Time 3 (*M* age approximately 13 years), but depressive symptoms at Time 2 did not predict sleep quality at Time 3. Future research should assess whether these patterns of findings are due to biological/ psychological changes that take place during the transition from childhood to adolescence. Furthermore, it would be worthwhile for future studies to explore bidirectional associations between sleep and psychosocial adjustment variables across different developmental transitions across the lifespan, as well as among different populations, including emerging adults who are not enrolled at university, pregnant women, mothers of infants, individuals employed in shift work, as well as the elderly. Such diverse samples may provide further insight into possible moderators (i.e., for whom, and under what conditions) of the bidirectional association between sleep and psychosocial functioning.

Other factors also should be included in future research as possible moderators of the association between sleep and psychosocial functioning. One such factor is the living context of university students. University students may choose to live at home, in residence (with or without a roommate), or off-campus (with or without room or housemates). In one qualitative study, based on a sample of university students across five different on-campus residences in France, authors found that students reported grave concerns regarding their sleep problems (Shaikh & Deschamps, 2006). This qualitative study, however, did not provide a quantifiable assessment of the prevalence of sleep

problems among participants and also did not have a comparative group of off-campus students. In contrast, in a more recent study based on a sample of on- and off- campus university students across 16 universities in China, authors found that students who opted to live on-campus reported better sleep (e.g., longer sleep duration, better subjective sleep quality) than students who lived off-campus. Future studies should further account for factors such as presence of roommates, as well as quality of relationships with roommates, and further explore how these contextual variables may serve to modify the nature of the association between sleep and psychosocial functioning.

Another possible moderator worth exploring is *morningness-eveningness preference*. There are marked individual differences in preferences for early versus late sleep-wake timing, which give rise to morning-types ("larks") and evening-types ("owls") (Horne & Östberg, 1976). Such behavioral differences in preferences for sleep-wake patterns are rooted in underlying physiological factors relating to the timing of melatonin onset, cortisol, and body temperature (Baehr et al., 2000; Gibertini, Graham & Cook, 1999; Horne & Östberg, 1976; Roenneberg, 2012). A consistent finding within the literature has been that evening-types report poorer sleep characteristics than morning-types. More specifically, evening-types report higher scores on subjective assessments of sleep problems, shorter sleep duration, and report more inconsistent bed times and wake times across the week and weekend (Gau et al., 2007; Merikanto et al., 2012; Taillard, Philip, & Bioulac, 1999; Thun et al., 2012; Fernandez-Mendoza et al., 2009; Vardar et al., 2008). Furthermore, in terms of daytime consequences, evening-types report taking naps more frequently and report higher daytime sleepiness than morning-types Giannotti et al., 2002; Roeser, Schlarb, & Kubler, 2013; Taillard et al., 2003). Additionally, relative

to morning-types, evening-types have been found to report poorer emotional adjustment, as indexed by higher levels of neuroticism, stress, and negative affect; and lower levels of positive affect, satisfaction with life and overall psychological well-being (Biss & Hasher, 2012; Drennan et al., 1991; Howell et al., 2008; Mecacci & Rocchetti, 1998; Randler, 2008, Randler, 2011). The patterns of findings – that of poorer sleep quality and more negative emotional adjustment among evening-types relative to morning types – provide an intriguing context for exploring morningness-eveningness as a possible moderator of the link between sleep and psychosocial adjustment. Would evening-types, perhaps, be more susceptible to the negative implications of poor sleep on emotional adjustment, relative to morning-types?

Moreover, beyond assessments of possible moderators of the associations between different sleep characteristics and various indices of psychosocial adjustment, future research also should explore the link between sleep and psychosocial functioning using a person-centered approach. The literature on sleep and psychosocial functioning has been dominated by the use of variable-centered analyses, in which information is deduced based on mean-level differences or participants' relative standing on variables. Using person-centered analyses, however, information is deduced based on the patterns of scores across multiple indicator variables, which yield unique subgroups of individuals, who may then be compared on other variables (Bergman & Magnusson, 1997; Bergman & Trost, 2006). For example, in study 1 and study 3, more sleep problems was significantly associated with decreased emotional well-being over time, using a variable centered approach. Using a person-centered approach (e.g., latent class analysis), however, one could determine whether there are subgroups of individuals who

differ in their patterns of scores across the sleep and emotional well-being variables. Such analyses could, for example, yield a subgroup of individuals who report significant sleep problems but experience positive emotional well-being; another subgroup who experience both significant sleep problems and significant emotional maladjustment; and yet another subgroup who may experience poor emotional well-being but report few sleep problems. These subgroups of individuals could then be compared on various psychosocial adjustment indices including academics, alcohol, media use etc. Given that both variable-centered and person-centered approaches provide unique perspectives, the use of more person-centered analyses to investigate the link between sleep and psychosocial adjustment would be a worthwhile extension of this literature.

Across the three studies of my dissertation, the use of self-reports (with the exception of academic grades, which were accessed from the Registrar's Office), was a limitation. In terms of the sleep characteristics, alternative assessments using objective sleep measures, such as actigraphy (Sadeh, Sharkey, & Carskadon, 1994) could be employed. Still, there is immense value in assessing participants' own subjective perceptions of their sleep experience. Ideally, future research would incorporate both objective and subjective assessments of sleep variables within the same study (e.g., Jackowska et al., 2011). Similarly, the measures of emotional well-being (including assessments of depressive symptoms, daily hassles/stress, emotion regulation etc.), in my dissertation were all based on participants' subjective reports. It would be worthwhile for future research to determine whether the patterns of results found across studies would be similar using objective measures of stress and emotion regulation. For example, across of number of studies, different cortisol parameters (e.g., cortisol awakening response,

cortisol slope, morning cortisol) have been used to index hypothalamic pituitary adrenal (HPA) axis functioning as a measure of stress (Adam, 2006; Adam & Gunnar, 2001; Adam et al., 2010). These assessments provide a biophysiological perspective to the study of psychosocial functioning. Incorporating such measures in future research would allow for a more holistic approach to the study of sleep and psychosocial functioning among university students.

A final limitation of my dissertation concerns the gender imbalance of the sample. Although gender was examined a moderator in Study 1 and was not found to moderate the patterns of findings, females were overrepresented (71.5%) in the sample, as the male-female ratio at the university from which participants were recruited was 42:58.

Strengths and Conclusion

My dissertation work has made important contributions to the sleep and psychosocial functioning literature, particularly by shedding light on the temporal ordering of effects between different sleep characteristics and various indices of psychosocial functioning. In keeping with findings from past research, the three studies of my dissertation included assessments of different sleep characteristics, including sleep quality, sleep duration, and sleep-wake inconsistency. In terms of psychosocial functioning, I employed assessments that tapped into various domains of university students' lives, including friendships, social ties at university, academics, intrapersonal adjustment, emotion regulation, and media use. The three studies of my dissertation were based on a conservative model, in which I controlled for autoregressive/stability effects, associations among all variables measured at the same wave, other predictors in the model, as well as Time 1 covariates of age, gender, and parental education. Findings from

my dissertation have important methodological implications for researchers, particularly in the modeling of sleep characteristics as predictors versus outcomes of psychosocial functioning variables. Findings also highlight the need for researchers to account for bidirectional associations, particularly between sleep quality and indices of emotional well-being, as well as between sleep quality and social ties at university.

Finally, the applied implications of my dissertation also are noteworthy. For university students, evidence across the three studies indicate that there may be viable points of intervention to facilitate better sleep quality among university students; these may include academics, friendships, social ties, and emotional well-being. Students also may benefit from improved interpersonal relationships and more effective emotion regulation strategies as a result of improved sleep quality. For university administration, and housing/ residence staff, findings across the three studies may be used to inform the structure and content of residence/ university-wide programming activities for university students. Generally, findings indicate that the sleep quality of university students impacts on various aspects of their social and emotional well-being; and also students' sleep quality is affected by various domains of students' lives psychosocial functioning (e.g., academics and friendship quality). In the absence of knowing which variable precedes the other in time, it is impossible to make empirically-based conclusions that may influence intervention programs that target sleep and adjustment behaviors. Thus, the findings of my dissertation provide important information regarding various points of intervention for both researchers and members of the general public (e.g., parents, university administration), who have a vested interest in facilitating successful adjustment among university students as they transition across their university years.

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APPENDIX A

Demographics

1. What is your birth date? _____year _____month _____day
2. Are you male or female? ○ Male ○ Female
3. What is the highest level of education that your MOTHER/STEPMOTHER (female guardian) whom you have lived with the MOST has completed? (If more than one mother, answer for one of them or if you have no contact with your mother/stepmother or female guardian please skip to Question 4 below)

○ Did not finish high school

○ Finished high school

○ Some college, university, or apprenticeship program

○ Completed a college/apprenticeship diploma (e.g., electrician) and/or technical diploma (i.e., graphic design, hair dressing)

○ Completed a university undergraduate degree

○ Completed a professional degree (e.g., masters, PhD, medical doctor, lawyer)

○ Still going to school

○ Don't know

4. What is the highest level of education that your FATHER/STEPFATHER (male guardian) whom you have lived with the MOST has completed? (If more than one father, answer for one of them or if you have no contact with your father/stepmother or male guardian please skip)

○ Did not finish high school

○ Finished high school

○ Some college, university, or apprenticeship program

○ Completed a college/apprenticeship diploma (e.g., electrician) and/or technical diploma (i.e., graphic design, hair dressing)

○ Completed a university undergraduate degree

○ Completed a professional degree (e.g., masters, PhD, medical doctor, lawyer)

○ Still going to school

○ Don't know

APPENDIX B

Insomnia Severity Index (Sleep problems/Quality)

Please answer whether you have any problems with the following

	No problem	Mild	Moderate	Severe	Very severe problem
a) Difficulty falling asleep	○	○	○	○	○
b) Difficulty staying asleep	○	○	○	○	○
c) Problem waking up too early	○	○	○	○	○
d) Problem staying awake	○	○	○	○	○

e) How satisfied are you with your sleep pattern?

○ Very satisfied ○ Satisfied ○ neither satisfied nor dissatisfied ○ Dissatisfied ○ Very dissatisfied

f) To what extent do you think your sleep patterns interfere with your daily functioning (daytime fatigue, ability to function at school or daily tasks, concentration, memory, moody etc.?)

○ Rarely interferes ○ Sometimes interferes ○ Often interferes ○ Very often interferes

APPENDIX C

Sleep Duration

a) During the WEEK, what time do you normally fall asleep? _____

What time do you normally wake up? _____

b) On WEEKENDS, what time do you normally fall asleep? _____

What time do you normally wake up? _____

APPENDIX D

Depressive Symptoms

Fill in the answer that best describes how often you felt or behaved this way DURING THE PAST TWO WEEKS

	NONE OF THE TIME (LESS THAN 1 DAY)	RARELY (1-2 DAYS)	SOME OF THE TIME (3-5 DAYS)	OCCASIONALLY (6-9 DAYS)	MOST OF THE TIME (10-14 DAYS)
a) I was happy	○	○	○	○	○
b) I did not feel like eating; my appetite was poor	○	○	○	○	○
c) I felt like I could not stop feeling sad, even with help from my family and friends	○	○	○	○	○
d) I felt that I was just as good as other people	○	○	○	○	○
e) I had trouble keeping my mind on what I was doing	○	○	○	○	○
f) I felt depressed	○	○	○	○	○
g) I felt that everything I did was an extra effort	○	○	○	○	○
h) I felt hopeful about the future	○	○	○	○	○
i) I thought my life had been a failure	○	○	○	○	○
j) I felt fearful	○	○	○	○	○
k) I was bothered by things that usually don't bother me	○	○	○	○	○
l) I talked less than usual	○	○	○	○	○
m) I felt lonely	○	○	○	○	○
n) I People were unfriendly	○	○	○	○	○
o) I felt like doing nothing	○	○	○	○	○
p) I has crying spells	○	○	○	○	○
q) I felt sad	○	○	○	○	○
r) I felt that people disliked me	○	○	○	○	○
s) I enjoyed life	○	○	○	○	○

APPENDIX E

Daily hassles

Below is a list of daily hassles that commonly bother students. Please indicate how often each one bothers you.

	Almost never bothers me	Sometimes bothers me	Often bothers me
a) Not having enough time	○	○	○
b) Not having enough money	○	○	○
c) My weight	○	○	○
d) Too much school work	○	○	○
e) Not enough close friends	○	○	○
f) Not enough time to talk with friends	○	○	○
g) Too few dates	○	○	○
h) How I look	○	○	○
i) Problems with roommates	○	○	○
j) Problems with friends	○	○	○
k) Getting to class on time	○	○	○
l) Problems with boyfriend/ girlfriend	○	○	○
m) Problems with my family	○	○	○
n) Being lonely	○	○	○
o) Others' opinions of me	○	○	○
p) Taking tests/exams	○	○	○
q) Household chores	○	○	○
r) Trying to get good marks	○	○	○
s) What I'm going to do after my undergrad degree is done	○	○	○
t) Thinking about where I'm going to live next year	○	○	○
u) Thinking about picking a major	○	○	○
v) Thinking about finding a summer job	○	○	○
w) Trying to manage both a job and school work	○	○	○

x) Not being able to meet my deadlines for school work	○	○	○
y) If living away from home, missing my family /friends/home	○	○	○

APPENDIX F

Self-esteem

Fill in the answer that best describes the way you feel

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a) On the whole I am satisfied with my life	○	○	○	○	○
b) I feel that I have a number of good qualities	○	○	○	○	○
c) I am able to do things as well as most people	○	○	○	○	○
d) I feel I do not have much to be proud of	○	○	○	○	○
e) I feel useless at times	○	○	○	○	○
f) I feel that I am a person of worth, at least equal with others	○	○	○	○	○
g) I wish I could like myself more	○	○	○	○	○
h) All in all, I tend to feel that I am a failure	○	○	○	○	○
i) At times I think I am no good at all	○	○	○	○	○
j) I take a positive attitude toward myself	○	○	○	○	○

APPENDIX G

Friendship quality

Thing about your FRIENDS and answer the following questions

	Almost always or always	Often	Sometimes	Almost never or never
a) I like to get my friends' points of view on things I'm concerned about	○	○	○	○
b) My friends can tell when I'm upset about something	○	○	○	○
c) When we discuss things, my friends care about my point of view	○	○	○	○
d) Talking over my problems with my friends makes me feel ashamed and foolish	○	○	○	○
e) I wish I had different friends	○	○	○	○
f) My friends understand me	○	○	○	○
g) My friends accept me as I am	○	○	○	○
h) My friends don't understand when I'm going through these days	○	○	○	○
i) I feel alone or apart when I am with my friends	○	○	○	○
j) My friends listen to what I have to say	○	○	○	○
k) My friends are fairly easy to talk to	○	○	○	○
l) My friends are concerned about my well-being	○	○	○	○
m) I feel angry with my friends	○	○	○	○
n) I can count on my friends when I need to get something off my chest	○	○	○	○
o) I trust my friends	○	○	○	○
p) I get upset a lot more than my friends know about	○	○	○	○
q) It seems as if my friends are irritated with me for no reason	○	○	○	○
r) I tell my friends about my problems and troubles	○	○	○	○

APPENDIX H

Media use

On an average WEEKDAY, how many hours do you spend doing the following?

	Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours
a) Going on my Facebook/Myspace/Twitter/e-mail/messenger	○	○	○	○	○
b) Watching TV shows/movies either on TV or computer	○	○	○	○	○

On an average DAY ON THE WEEKEND, how many hours do you spend doing the following?

	Not at all	Less than 1 hour	1-2 hours	3-4 hours	5 or more hours
a) Going on my Facebook/Myspace/Twitter/e-mail/messenger	○	○	○	○	○
b) Watching TV shows/movies either on TV or computer	○	○	○	○	○

APPENDIX I

Difficulties with Emotion Regulation

Please indicate how often the following statements apply to you

	Almost never	Sometimes	About half the time	Most of the time	Almost always
a) When I'm upset or stressed, I have difficulty concentrating	○	○	○	○	○
b) When I'm upset or stressed, I have difficulty thinking about anything else	○	○	○	○	○
c) When I'm upset or stressed, I can still get things done	○	○	○	○	○
d) When I'm upset or stressed, I believe that wallowing in it is all I can do	○	○	○	○	○
e) When I'm upset or stressed, I know that I can find a way to eventually feel better	○	○	○	○	○
f) When I'm upset or stressed, I start to feel very bad about myself	○	○	○	○	○

APPENDIX J

Emotion Reactivity

Please rate the following statements

	Not at all like me	A little like me	Somewhat like me	A lot like me	Completely like me
a) When something happens that upsets me, it's all I can think about it for a long time	○	○	○	○	○
b) My feelings get hurt easily	○	○	○	○	○
c) When I experience emotions, I feel them very strongly/intensely	○	○	○	○	○
d) I tend to get very emotional very easily	○	○	○	○	○
e) When I feel emotional, its hard for me to imagine feeling any other way	○	○	○	○	○
f) If I have a disagreement with someone, it takes a long time for me to get over it	○	○	○	○	○
g) When I am angry/upset, it takes me much longer than most people to calm down	○	○	○	○	○
h) I get angry at people very easily	○	○	○	○	○
i) I am often bothered by things that other people don't react to	○	○	○	○	○
j) When something bad happens, my mood changes very quickly. People tell me I have a very short fuse	○	○	○	○	○
k) People tell me that my emotions are often too intense for the situation	○	○	○	○	○
l) I often get so upset it's hard for me to think straight	○	○	○	○	○
m) Other people tell me I'm overreacting	○	○	○	○	○

APPENDIX K

Social ties

Fill in the answer that best describes you:

	Not at all like me	A little like me	Somewhat like me	A lot like me	Completely like me
a) I have several close ties at university	○	○	○	○	○
b) I am satisfied with how much I am participating in social activities at university	○	○	○	○	○
c) I am meeting people and making friends at university	○	○	○	○	○

APPENDIX L

Consent Form

Project Title: Stressed @ Brock?

Principal Investigator: Teena Willoughby (Professor)
Department of Psychology, Brock University
Email: twilloug@brocku.ca; Phone: 905-688-5550, ext 5474

INVITATION.
You are invited to participate in a study that involves research. The purpose of this study is to explore stress, coping, and academic achievement in undergraduate students. We are interested in looking at factors that both contribute to and reduce stress, as well as promote academic success during the transition to university. We are particularly interested in what happens over time, as students go through university.

WHAT'S INVOLVED
As a participant, you will be fill out a survey assessing aspects of your university experience that create and reduce stress, as well as questions that assess mental health, such as academic pressures, depression, anxiety, suicide ideation, self-harming behaviors, spirituality, personality, and coping.
Participation will take approximately 60 minutes of your time. In addition to completing the questionnaire, your participation also involves giving your consent to allow the researchers to compare your responses with your academic records at Brock (university and high school course selection and grades, course withdrawals, and a yes or no to whether there have been any suspensions). Records will be accessed annually throughout undergraduate studies, at the end of each winter term each year you are registered at Brock

POTENTIAL BENEFITS AND RISKS
Benefits of participation include either (a) the payment of $10 or (b) proof of one hour research participation for credit in any one course that offers such credit, as well as the experience of taking part in psychological research. You will also get the opportunity to reflect on your life and your experiences in a confidential manner. The only anticipated risks associated with participation in this study is that some of the questions focus on negative aspects of yourself or negative events in your life, which may result in some discomfort. There is some loss of privacy that your grades and course selections will be accessed by the researchers, but please be assured that these data are used for research purposes only and will be kept entirely confidential.

Please indicate your choice between (a) payment and (b) proof of one hour research participation for course credit by checking ONE of the two spaces below:

____ I wish to receive $10 for participation OR
____ I wish to use this form for one hour course research participation credit

CONFIDENTIALITY

All information you provide is considered confidential. Because our interest is in the average responses of the entire group of participants, neither you nor your responses will be identified individually in any way in written reports of this research. Group data only may be published, presented at conferences, used to evaluate programs, or used for secondary data analyses by other researchers. Data collected during this study will be stored in a secure location in Teena Willoughby's office in Plaza 519. Your name will not be kept in the same data file with your questionnaire responses; instead, your name will be kept in a separate file that will be available only to Dr. Teena Willoughby. The student investigators involved in data collection/analyses will only access the unidentifiable data; they will not be able to identify your responses. Note that your responses will NOT be made available to Brock University itself, so there will be no university record of your responses.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time without any penalty or loss of benefits to which you are entitled. If at some future date, you decide to withdraw your permission for the researchers to obtain access to your academic records, you may do so by contacting the researchers, without losing your payment or proof of participation. Because we are interested in what happens to students as they go through university, you will be contacted via email (using the email address you provided on this consent form or when you signed up for the study) in the future with opportunities to participate in follow-up studies, but your participation in those studies is completely voluntary.

PUBLICATION OF RESULTS

Results of this study may be published in professional journals and presented at conferences. We will also email you with a summary of the results from this study by August 2009.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact Dr. Teena Willoughby, Faculty Supervisor, using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (file 09-118). If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca. Thank you for your assistance in this project. Please keep a copy of this form for your records.

Name (printed):_____
Email address: _____
Student number:_____
Signature:_____
Date:_____

Brock University
Research Ethics Office
Tel: 905-688-5550 ext. 3035
Email: reb@brocku.ca

Social Science Research Ethics Board

Certificate of Ethics Clearance for Human Participant Research

DATE: February 3, 2012

PRINCIPAL INVESTIGATOR: WILLOUGHBY, Teena - Psychology

FILE: 09-118 - WILLOUGHBY

TYPE: Faculty Research STUDENT:
SUPERVISOR: Teena Willoughby

TITLE: Stressed @ Brock?

ETHICS CLEARANCE GRANTED

Type of Clearance: MODIFICATION Expiry Date: 1/31/2013

The Brock University Social Sciences Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement. Clearance granted from **2/3/2012** to **1/31/2013**.

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the expiry date, you are required to submit a Renewal form before **1/31/2013**. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page at http://www.brocku.ca/research/policies-and-forms/research-forms.

In addition, throughout your research, you must report promptly to the REB:

a) Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) All adverse and/or unanticipated experiences or events that may have real or potential unfavourable implications for participants;
c) New information that may adversely affect the safety of the participants or the conduct of the study;
d) Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved:

Jan Frijters, Chair
Social Sciences Research Ethics Board

Note: Brock University is accountable for the research carried out in its own jurisdiction or under its auspices and may refuse certain research even though the REB has found it ethically acceptable.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of research at that site.